MONITORING, VERIFICATION AND EVALUATION UNIT
AGRICULTURAL POLICY REFORM PROGRAM

MVE UNIT
APRP

Sponsored by:
Government of Egypt,
Ministry of Agriculture and Land Reclamation

United States Agency for International Development/Egypt
Office of Economic Growth, Competitiveness and Agricultural Development Division

IMPROVING CROP AREA ESTIMATION IN EGYPT

Morsy A. Fawzy

Abdallah M. Zein El-Din

Mostafa Bedir

Ramzy Mubarak

Bayoumi Abdel Meguid Bayoumi

Mahmoud Abdel Fattah

EQI

Abt Associates Inc.

Prime Contractor:
Abt Associates Inc.

Subcontractors:
Environmental Quality International,
Management Systems International

USAID Contract No. 263-0219-C-00-7003-00

July, 2002

Project Office: 15th Floor, 7 Nadi El Seid Street, Dokki, Cairo
Telephones: (202) 337-0357, 337-0592, 337-0482
Fax: (202) 336-2009

Impact Assessment
Report No. 31

TABLE OF CONTENTS

LIST OF ACRONYMS

ANOVA	Analysis of Variance
APRP	Agricultural Policy Reform Program
ARC	Agricultural Research Center
AERI	Agricultural Economic Research Institute
ATUT	Agricultural Technology Utilization and Transfer (USAID funded project)
CAAE	Central Administration for Agricultural Economics
CAPI	Central Administration for Planning and Information
DF or df	Degrees of Freedom
EAS	Economic Affairs Sector
ESA	Egyptian Survey Authority
FAO	Food and Agriculture Organization (UN)
GARPAD	General Administration for Reclamation, Projects, and Agricultural Development
GIS	Geographic Information System
GOE	Government of Egypt
GTZ	Deutsche Gesellschaft fuer Technische Zusammenarbeit
IFPRI	International Food Policy Research Institute
MALR	Ministry of Agriculture and Land Reclamation
MOA	Ministry of Agriculture
MIWR	Ministry of Irrigation and Water Resources
MS	Mean Square
MHTS	Ministry of Home Trade and Supply
MVE	Monitoring, Verification and Evaluation Unit
PBDAC	Principle Bank for development and Agricultural Credit
PSU	Primary Sampling Unit
RDI	Reform Design and Implementation (APRP Unit)
SS	Sum of Squares
UAES	Undersecretary of Agricultural Economics and Statistics
US	United States
USAID	United States Agency for International Development
USDA	US Department of Agriculture

EXECUTIVE SUMMARY

To estimate or forecast the volume of production of the major field crops good data are needed for both yield and crop area. The MVE unit had conducted some activities regarding yield, but APRP had not made any effort to improve the estimation of area. It is essential to have good area data because these data are used to document the growth rate of production and to study the impact of agricultural policy on these crops. This is important both for impact assessment in general and for policy makers in Egypt in particular.

The method used by the Egyptian Survey Authority (ESA) to obtain crop area by complete enumeration and measurement on the ground was very expensive. Hence it was necessary to develop a sampling technique of partial enumeration to reduce costs and effort. The area under wheat since 1957 and the area under cotton since 1958 have been estimated on the basis of a sample involving measurement of area by a kassaba in 50% of the cultivated land in Egypt. But since1990, there have been many problems in the use of this objective method such as: 1) the last base year (1961) became out of date. 2) the budget, which was about LE 3-4 million/year. 3) The cadaster maps are too old. Therefore, to obtain crop area estimates, ratios were used to adjust the estimates of inquiry in the sample measured by the ESA. However, the agricultural year 1999/2000 was the last year in which the ESA area measurements were used. MALR decided to stop using this method, and tried to find a more accurate and less expensive technique to. The proposed in this study technique is based on a check-sample of the area determined by subjective methods of the agricultural local staff to remove its bias. The subjective methods based on inquiry by agricultural extension staff have become the only method for crop area estimation. Therefore the check-sample is one potential method to use in order to remove the indeterminate bias of this subjective method. Another way to improve the quality of crop area estimates is to use new instruments. The team tested such instruments in the selected governorates.

The main objectives of the area estimation activity were to:

- Assess the availability and quality of agricultural data for the area of major summer crops (cotton, rice and maize) and winter crops (wheat, berseem and fava beans)
- Propose an advanced objective methodology and sampling procedure to estimate the area of these crops.
- Estimate the main winter crops area using newly purchased, modern equipment and train the EAS staff in using it in the selected governorates.
- If possible, propose an advanced objective methodology and procedures to forecast the expected area of summer crops at the time of measuring the winter crops area.

The objectives mentioned were achieved by conducting a check-sample survey of area in conjunction with crop-cutting surveys. The MVE team adopted a work plan of two phases: phase one for summer crops and phase two for winter crops. During the first phase, the team (a) assessed the current procedure for crop area estimation, with special attention given to the major summer field crops, i.e. cotton, rice, and maize, (b) examined the procedure for obtaining the published statistics (of MALR), starting from the village level, (c) developed an improved method to be adopted for estimating and measuring the crop area of these crops,(d) selected a representative sample of districts and villages and conducted a limited sample survey of key data elements in these sites to test the feasibility of data collection, and (e) conducted a statistical analysis to compare the data obtained from the survey with the data collected by MALR at the governorate. Level. The pilot study was conducted in the following governorates: Gharbia, Behira, Dakahlia, Minia and Assiut.

In the second phase, the techniques that were developed during the summer season and the new equipment that the EAS has purchased were applied during the winter season. The EAS staff were trained on using the new equipment in the same governorates in addition to Sharkia governorate.

An additional objective of the second phase was to develop a forecasting procedure for the area of the major summer crops using the data on area of winter crops and other information. This procedure was tested using the area data from the MALR indicative cropping pattern and also the actual area.

It is important to note here that the objectives of this work were not only measuring and plotting the area of each farmer's field, but also choosing the best method to measure crop area.

The area under each selected parcels was estimated by four methods: (a)direct measurements by the MVE team using a modern optical instrument, (b) direct measurement by sampling staff using a tape on the ground, (c) inquiry from the local extension staff in the village, (d) farmers' estimate for his crop area. These areas were compared with each other by applying statistical analysis. More information about forecasting summer crops was collected from farmers and local staff. The data were carefully checked and reviewed, and field areas were computed. All of the data were submitted to the EAS.

On the job training for some sampling staff was conducted regarding the use of the new instruments, and the others were trained in using tape and in survey data collection. An advanced training course was held for area measurement and calculation.

The check-sample technique using the new optical instrument proved that subjective methods based on inquiry by extension agents or farmers' data overestimate crop area and need to be adjusted, while using tape was relatively close to instrument measures. To adjust and correct the extension estimates or to remove bias, ratio estimates and regression estimates were successfully used to obtain area estimates with acceptable levels of sampling error at both the governorate and the total sample levels.

The study demonstrated the possibility of using a farmers' planting intention survey to forecast the expected area. Using data of the indicative and actual cropping pattern in the selected villages level gave good results in this domain.

Recommendations can be summarized as follows:

- The necessity for using check-sample to improve crop area estimation.
- Apply this method in more governorates
- Increase sample size depending on optimum sample size calculated
- Purchase more optical instruments, compasses and metallic tapes.
- More training for sampling staff
- Further research for crop area estimation improvement.

VOLUME I: SUMMER CROP AREA ESTIMATION

Morsy Ali Fawzy
Abdallah Zein El-Din
Mostafa Bedir
Bayoumi Abdel Meguid Bayoumi

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGMENTS

The authors would like to acknowledge the wise guidance and scientific advice of Dr. Saad Nassar. Appreciation is also extended to Eng. Mahmoud Nour for his strong support during the study implementation. Special thanks go to Dr. Mohamed Omran for the long discussions, feedback, and his participation in designing and implementing this study. The authors are greatly indebted to Dr. Gary Ender, Chief of Party of the MVE Unit for his guidance, participation and support in formulating and implementing this report.

Appreciation should be extended to Eng. Mohamad El Shahed, the head of theEconomic Affairs Sector. Without his cooperation and assistance, this study would never have been completed. Appreciation is also extended to Eng. Abd El Razik Hassan, the head of the Central Administration of Agricultural Economics and Eng. Saed El Agaty, the Head of the Sampling Department, for their full support and cooperation.

The authors also would like to acknowledge the hard work and dedication of the researchers who conducted the field investigations: Eng. Mohamed El Sayed Abed, Sayed Gad El Moula, Abdel Hameed Mokhtar, Noshy Abdel Rahmna and Abdel Aziz El Samahy.

Appreciation is also extended to Mr. Mohamed Ibrahim and Mr. Mohamed Taha from the Faculty of Agriculture, in Alexandria University for their hard work in applying the new instruments.

Special thanks go to Mrs. Yvonne Louis for her hard work in data entry, tabulation, and file manipulation.

Finally, any errors and omissions should be attributed to the authors and not to the APRP, USAID, or MALR.

EXECUTIVE SUMMARY-SUMMER CROPS

To estimate or forecast the volume of production of the major field crops, good data are needed for both yield and crop area. The MVE unit had conducted some activities regarding yield, but APRP had not made any effort to improve the estimation of area. It is essential to have good area data because these data are used to document the growth rate of production and to study the impact of agricultural policy on these crops. This is important both for impact assessment in general and for policy makers in Egypt in particular.

The main **objectives** of this activity were to:

- Assess the availability and quality of agric ultural data for the area of major summer crops (cotton, rice and maize).
- Propose an advanced objective methodology and procedures to estimate the area of these crops.

Methodology. To achieve the above objectives, the MVE team adopted the following work plan. The team:

- Assessed the current procedure for crop area estimation, with special attention to the major summer field crops, i.e. cotton, rice, and maize
- Examined the procedure for obtaining the published statistics (of MALR), starting from the village level
- Reviewed any extension agents' notebooks for the major summer field crops in the selected villages.
- Developed an improved method to be adopted for estimating and measuring the crop area of these crops.
- Selected a representative sample of districts and villages and conducted a limited sample survey of key data elements in these sites to test the feasibility of data collection
- Carried out on the job training for the sampling staff at the governorate level in applying the improved method of measuring crop area
- Conducted a statistical analysis to compare the data obtained from the team's surveys with the data collected by MALR at the governorate level
- Established a database for the crop area data collected by the study

The pilot study was conducted in the following governorates: Gharbia, Behira, Dakahlia, Minia and Assuit.

Assessment of the Techniques

Old Measurement Technique (Taping). The sampling staff used to estimate the area of each field based on the following steps:

- Measuring all field lengths using the tape (20-50m).
- Measuring one of the traverse angles.
- Drawing a clear sketch showing the measurements.

- Dividing the traverse into triangular pieces, and calculating the area of each triangle separately and summing up the triangles' area in order to estimate the area.

Assessment. Practically, the old technique is suitable for small areas only. Some specific problems are:

- Using the tape for measuring lengths longer than its length means measuring the line part by part without alignment.
- This method always gives higher lengths than the original lengths by 10-15%.
- Field staff were measuring lengths on vertical slopes instead of the correct horizontal lengths. Measuring one angle for each traverse is not enough to draw the traverse for most cases.
- The method for measuring the internal angles using the surveying triangle is not correct.
- This method never gives close traverses.
- In some cases when there are curved edges, they could not handle it with taping. They simply assume that it is straight line, which creates another source of error.

The principal sources of linear measurement error are: Tape not stretched straight, wind, incorrect alignment (horizontal and vertical), careless plumbing over point, erroneous length of tape, variation in temperature and incorrect tension. Some of the above errors are caused by carelessness or lack of training of the staff; others are caused by not accounting for those errors that are inherent in the tape.

New Measurement Technique (Optical Instruments). At the beginning of the activity, the team decided to use the theodolite for measuring lengths and angles for each traverse, and using the tangential method for measuring lengths. To simplify the work, the team used the one-location method. This means that one should put the instrument on one corner of the traverse and measure the lengths of the two edges and diagonal length. If the traverse has more/less than 4 edges, one can measure it by sending rays to each corner from the one-point location and measuring all lengths and angles. By using the same calculation method described before, one can estimate the traverse area. If the traverse has curved edges, additional work should be done by sending many rays along the curve length to draw it.

Assessment. The first trial was fairly good, except that the theodolite needed time to be adjusted, and the tangential method needed more calculations to give the lengths. Therefore, the team decided to use the surveying level with the fixed hair stadia method for measuring lengths and angles. The team also used the two-point location method and the magnetic compass to find the directions.

The stadia method provides lengths directly, and the two-points location method gives five lengths for each traverse without any plotting correction. This method also eliminates any personal error. Moreover, this method provides a chance to double check each line length by calculation as described before.

Main Findings

Taping Measurements. The team's observations on taping are as follows:

- Field staff was measuring the field area as a rectangular area, neglecting any changes in edge shape and only measuring length and width.
- In some cases, there was error in stating the field location correctly.
- In most cases, only one angle was measured.
- It is important to note that the method used for measuring angles is not correct. Based on various tests, it was found that nobody knows how to use the surveying level for the measurement of angles.

Optical Instrument Measurements. The team found that:

- The stadia method with the level is the most suitable method to measure the distances for crop area estimation.
- The level provides not only distances and internal angles of traverses, but also changes in the traverse sides (curved, broken line).
- One can use the level easily to re-plot a complete cluster or italics with all its details following the two crop area estimation studies, a recommended training program was conducted to cover all the needs of the sampling department staff.
- The new instrument purchased by the MALR provides highly accurate measurements, including an auto-focus facility that significantly reduces measuring time.

Statistical Analysis

Matched pair t-test analysis showed significant differences between new instrument measurements and taping measurements in all governorates. The 95% confidence intervals of the ratio estimates of new instrument for almost all crops were mostly shorter than that of the taping measurements method. Thus, the ratio estimates (correction factors) obtained from the new instruments are more efficient to be used in crop area estimation. The final results of the study showed the fitted equations of the weighted ratio regression for cotton, maize and rice, as well as the total crop area obtained from the agricultural department before and after adjustment. These show that in general there is an overestimation of crop area in the selected governorates.

Conclusion and Recommendations

It is concluded that:

- The taping process is not suitable for crop area estimation, and the method of measuring angles using the surveying triangle is not correct.
- The new instrument method was more accurate than all other measurement methods.
- It is recommended that it be used to derive correction factors for adjustment of the extension agents' crop area estimates.

1. INTRODUCTION

1.1 Background

Egypt has a long history of gathering statistical data, but the quality has been variable. The Data Quality report is recommended reading for those interested in detailed information. Prior to 1955, only subjective methods were used to estimate crop areas. Experience has shown that these estimation procedures are usually unreliable.

Estimation of the major crops production depends on the yield (productivity multiplied by the area). Several sampling techniques and researches were used in Egypt for the last 45 years. Theses techniques were applied by the Economic Affairs Sector (EAS) to obtain reliable estimates for both area and productivity for the major crops, applying the objective method and actual measurements to obtain reliable estimates, free from any personal bias.

Although the development and upgrading of yield estimation methods were continue succeeded but crop area estimation faced several problems, that leaded to stop the actual area measurements using a sample of size 50% of the total planted area. A list of fields used to be sent and physically measured by the Egyptian Survey Authority (ESA) to verify the data quality of the planted area collected by the extension agents and corrects it accordingly.

Unfortunately, EAS stopped measuring the planted area of the major crops at the end of 1999 year. Therefore the only available data sources for the crop area estimation is the Agricultural Department at the district and governorate levels, which is collected and published by EAS. These data are usually collected by the extension agents at the village and district levels and use to be called "a complete survey data".

The request to do this work came from the EAS of the MALR, who has had an interest in improvement of agricultural statistics for some time.

1.2 Study Objectives

The main objectives of this activity are to:

- Assess the availability and quality of agricultural data for the planted area of major summer crops namely cotton, rice and maize.
- Propose an advanced objective methodology and sampling procedures to estimate the planted area of these crops in the selected governorates.

The work is a natural follow-on to the data quality study made in 1999. This type of work was recommended in that report. It will enable MALR to better monitor and evaluate agricultural production, and verify the effects of agricultural policy.

2. ASSESSMENT OF CROP AREA ESTIMATION METHODS IN EGYPT

2.1 Background

Before 1957, area crop survey of the major crops cotton, rice, wheat and sugarcane was used to be completely surveyed using cadastral maps with scale 1:2500. This complete survey used to be carried out by the Egyptian Survey Authority (ESA), where all sides of the planted field were measured. Planted areas were colored marked on the maps and used to Calculate the net-planted area, excluding the unplanted area from the maps using the planimeter. In spite of being expensive, the complete survey had several errors:

1. Some planted segments (fields) may not be marked on the map.
2. Some vegetable or other secondary crop planted area may be added to the studied planted area of the major crops.
3. The measured area of the major crops may include canals, drains, roads, …etc.
4. Field and planimeter measurement errors.

These errors could be avoided (Ghazi, 1962) using a check sample along with crop-cutting experiments of cotton and rice in 1965. In this sample the planted area was measured by tape and area was calculated by the triangles using the planimeter to get the net-planted area.

Mubarak (1996) indicated that, the cotton area estimation of the agricultural departments in 1993 and 1994 were biased upward amounted by 4% and downward in 1996. However; he added, for rice crop area, the bias was very high upward, 16% and 18% in 1995 and 1996 respectively.

2.2 Present Methods

The current agricultural statistics, including crop area statistics, are usually gathered through the governorate and district Agricultural Affairs Offices. At each governorate and district level, extension agents carry out what is known as a "complete survey" to estimate the crop planted area. This information is usually recorded in notebooks kept with the extension agents, who are employed in the agricultural units (cooperatives) at the village level.

The extension agent at each agricultural unit is responsible for 150-250 feddans. The extension agent at the village level advises the farmers and gathers information about the major crops (planted area, agricultural inputs and output). Each extension agent is supposed to have a structured notebook in which information on major crops like cotton, rice, maize and wheat is recorded for each farmer at the *hod* level. There are two types of structured notebooks, one for cotton only the other for all other crops at the hod level. During the January-March period, the extension agents summarize all the information collected, including planted area, and pass it to the district level; those data are then forwarded to the governorate. This method is called a "complete survey" of all farms producing a specific crop. The agricultural departments at the district and governorate levels accumulate all the information and pass them to the higher levels Cairo/ MALR/EAS.

2.3 Findings

The MVE study team noticed the following:

- The currently method known as "a **complete survey"** is literally described, is just a subjective method used to collect information about the planted area by the local extension agents in the governorates. This was deduced by interviewing key people at the actual field.

- The Extension agents at the Agriculture Units usually advise the farmers about their prospective planted area in winter season and reports it to the agricultural units (coop) in January, and the same is usually done in March for the summer crops. The Agriculture units in each village send this information to the Agriculture Department in the district, which then releases it to the Agriculture department in the Governorate. This information is usually subjected to personal bias and provides low quality data.

- The study team asked an extension agent to bring his notebooks or sheets; it was found that they only have detailed information about cotton in summer and just the planted area of wheat in winter season.

- The team was told the method, which had been used in the past, about 5 years ago, used to be carried out twice a year, once in the winter and again in the summer season. The data collected were sent to the Bank of Development and Agriculture Credit branch in the district, which then made available agricultural inputs and marketed the agricultural products. This survey was really complete and used to produce good quality data; unfortunately it had been stopped since the Policy of PBDAC changed.

2.4 Survey by Sample Methods

Survey by the sample (using the complete survey year as base year) 1957-1996. A random of size 50% of total planted area was used to estimate wheat planted area in 1957 and for cotton and rice in 1958. The actual measurements were done by the ESA. The total planted area in each district was divided into primary sample units (clusters each of which has size about 2000 faddans), 50% of each district was selected each year and a sample list used to be sent to the ESA to estimate the planted area using an Egyptian measuring unit called *hasaaba*. These planted areas used to be color marked on maps of scale 1:2500. The net-planted areas were then measured and calculated by planimeter. The results used to be sent back to EAS/sampling department, where ratios were used to estimate the planted area relative to the base year.

Koshal (1962) proved that the standard error of the ratio estimates was less than of the average, according to the high correlation between crop area in the base and the current year. He also explained that, a sample of size 25% could be used for area estimates with standard error of only 0.5% at the governorate level.

Survey by sample (to correct Agriculture Department's data) 1990-1999. Mubarak (1977) indicated that the last base year, which was used to estimate crop area by sample was 1961. It is very far away to be used to estimate the current statistics of planted area of the major crops. So, it was recommended using the sampled area estimation to correct the agricultural surveyed data.

In 1990, the agricultural surveyed data was used, replacing the 1960 base year data and corrected by ESA actual measurement data obtained from a sample of size 50% of the total planted area using ratio estimates technique. However, this technique faced several problems, too:

- The primary sample unit definition was not unique or unified for ESA and agricultural departments.
- There were different names for the same *hod*.
- There were difficulties to verify the differences in the field.
- This technique was used from 1990-1999. The ESA's measurements shouldn't be influenced by any government officials; however much of their work was done in collaboration with the extension agents, thus, there might be some dependence at that level.

The sampling department used to aggregate all the planted area measurement data received from ESA. It then compared them with the total cultivated area of the same district received from the agricultural department (or the complete surveyed data). This surveyed data was then corrected using the ratio estimate technique as follows:

$R=Y/X$
Where;
Y=Crop planted area (Measured data).
X=the crop planted area (Complete surveyed data.)

And the surveyed is corrected as follows:

The corrected estimated area obtained by:
$Y=RX$

Mubarak (2001) made a comparison between the different methods of crop area estimation of wheat, cotton and rice grown in 1998; the results are shown in Table 1.

Table 1: Crop Area Estimation Using Different Methods in 1998

(1000 feddans)

Methods	Wheat		Cotton		Rice	
	Feddans	**Index no.**	**Feddans**	**Index no.**	**Feddans**	**Index no.**
ESA-before adjustment	1858	93	1029	131	1969	159
ESA-After adjustment	1936	97	800	102	1307	106
Agricultural Department	1985	99	806	103	1218	99
Final estimation committees	1999	100	773	100	1236	100

Results in Table 1 showed different values, especially that of ESA before verifying and adjustment compared with other methods for rice crops, where its estimation was increased by 59% from the final estimation. Therefore, it is essential to check, verify and adjust ESA data to increase its quality and make the right adjustment in the data or in the methodology.

This method was not only expensive, (about LE. 2 million annually), but also its quality was questionable. Unfortunately, this objective method has been stopped since the beginning of year 2000. Therefore, the only available source for the planted area information is what is called Agricultural Department data, the subjective one.

Therefore, it was essential for the Ministry of Agriculture to come up with an alternative method to check and evaluate the cotton planted area and the other major summer crops like rice and maize. This is the goal of this study.

Mubarak (2001) introduced a pilot study to adjust and verify the agricultural area data of wheat. A multistage stratified sample of total size 28 fields was selected from three governorates (8 from Behira, 8 from Gharbia and 12 fields from Assuit). Sampled fields of wheat in the 1999/2000 season were measured using the tape and compared with the agricultural data. In Behira, data analysis indicated a 14% difference between the actual measurement and the agricultural data, and the ratio estimate of both was 0.86 respectively. While in Gharbia, the difference was about 7% between the actual measurement and the agricultural data and the ratio estimate was 0.93. Results in Assuit showed also negative difference between the actual measurements and the agricultural data, and the ratio estimate was about 0.93. He used the ratio and regression estimate to correct the agricultural data in the three governorates under the study.

3. TESTING A CHECK SAMPLE AND OPTICAL INSTRUMENTS

In this pilot study, it is assumed that any governorate consists of a population of area units (fields) distributed over a geographic area. Each governorate is divided into districts and each district is divided into a known number of clusters (village, basin or group of small basins) of different crop fields. Each cluster is uniquely defined with physical boundaries and its area ranged from 150 to 250 feddans. Each is divided into a known number of fields, each of which has a measured planted area. The parameter of interest is the total planted area at the district and governorate levels. Selecting a sample of clusters and a sub sample of crop fields from the selected clusters collects the planted area information. Therefore, a cluster sub-sampling scheme is used to get a representative sample to estimate the major summer crops planted area in the studied districts and governorates. For the economy of the yield work and supervision, it was decided as far as possible to purposively select the cotton forecasting clusters, from each selected districts, which have at least the three studied summer crops namely, cotton, maize and rice. Cluster is considered as the primary sampling unit, while the crop field is the secondary sampling unit. However, the study considered the randomization selection, only during the crop field selection in the second stage. It should be noticed that the new applied technique is called a check sample procedure. The improved method suggested by the team consists of two parts. The first one is to apply the check sample techniques, and the second part is to test new instruments (optical instruments) in measuring fields.

3.1 Methodology

The following statements outline the actions taken by the MVE team as they worked to accomplish their goals:

- Select a team comprised of MALR, ARC, University, and staff experts.
- Establish the goals for area estimation.
- Review all past reports, instructions, manuals, models, and data.
- Review all available data and how they were used to make area forecasting.
- Observe current fieldwork, documents and estimation process.
- Field observations of current procedures applying the new instruments.
- Suggest and test new procedure and forms
- Recommend models for future forecasting work along with a schedule of implementation.
- Recommendations for improved sampling procedures.
- Recommend improvements to survey procedures and forms.
- Recommended procedures and models that should provide accurate, timely, cost effective forecasts and be manageable. If possible include an estimate of manpower, equipment and budget requirements.

3.2 Implementation

1. The MVE team visited several governorates (Gharbia, Minya, Assuit, Behira and Dakahlia) During June and July to assist the existing systems of planted area estimation methods used by EAS / MALR.
2. The MVE Planted area estimation team interviewed a few key informants in each visited governorate. They collected information about the flow of planted area data of the major summer crop from the agricultural units in the village to the agricultural departments in the governorate via the districts, i.e.

    - The team interviewed the director of the sampling department in each district and governorate.
    - The MVE team interviewed the local agriculture extension agents and farmers in the selected villages. They also collected information about how data are collected on crop rotations and the planted area of major summer crops, especially cotton, maize and rice.

3. The MVE team, using its own staff and in cooperation with the sampling local staff, double checked the selected planted area measurements using two methods:

    - Tape measurements.
    - Instrument measurements.

3.3 Study Areas, Sample Selection and Operational Work

The MVE team decided to choose five governorates based on their relative importance in the total planted area of cotton, maize and rice, as well as to provide dispersion geographically. Those governorates are Gharbia, Minya, Assiut, Behira and Dakahlia.

Applying the above mentioned survey procedure, three districts were purposively selected from Gharbia, Minya and Assiut, while four districts were selected from Behira and Dakahlia. A two-stage cluster sample has used to select two clusters from each selected district, and a few different numbers of the studied crop fields were randomly selected from each selected cluster based on the relative importance of the planted area of the studied crop. For example, four cotton forecasting fields were selected in some governorates to compare the results with the ongoing cotton forecasting study. Also, three fields were selected from each cluster in the second stage to increase the sample size in the other governorates, namely Minya and Assuit, which have only cotton and maize grown there. This diversity of the studied areas, different crops and representative sample enabled testing for differences between different methods of crop area estimation.

The MVE team assigned three working days in each studied governorate; however, the field trips to Bahira and Dakahlia were extended one day more. They interviewed key informants in each governorate: directors of sampling departments at the district and governorate levels and local farmers and extension agents at the district and village levels. Subjective information about the planted area was collected. In addition, all sampled fields of cotton, maize and rice were visited and actually measured by the study team. Objective field measurements were obtained using tape measurements and the new instruments. All these actual measurements of the selected fields were illustrated on sketches in the field.

A multidisciplinary team consisting of a senior statistician, senior agricultural engineer, agricultural economist and research assistant was assigned to assess the past and present methods used by MALR/EAS for crop area estimation and suggest a new method to improve sampling procedures and proper way to estimate crop area. The team started the operational work in Gharbia on 23 of June 2001. Then the team took a field trip to Minya and Assuit during the period 29/6 to 5/7/2001. Bahira was visited during the period 9-12/7/2001 while Dakahlia was visited during 16-19/7/2001. During these visits, the team members spent long days measuring the selected fields, interviewing key people, and training the sampling local staff on the right way to measure the field area. A double check of the calculated field area was also carried out using tape measurements and new instruments to assist and verify the present work.

Many difficulties were encountered during the operational field work, ranging from flooded fields, misallocated the selected clusters and fields. Field trip details are explained hereinafter.

3.4 Findings

The MVE team found that:

- If the field is nearly rectangular in the shape, two enumerators used a measuring tape to get the length of one long and one short side. The area of the field is calculated by multiplying the length by the width. But this was not always the case in all fields that the MVE team visited.

- In most of the cases, the sides of the fields were curved, and the shape is quite complex.

- Sampling staff don't note down how many times the tape was fully unwound.

- When they measure the field, some sampling enumerators don't fully unwind the tape.

- When the local team was asked, how could they measure these irregular shapes, they answered that these fields could be broken up into triangles and rectangles, which can be used to derive the area of the field.

- When they were asked, how could the area of the triangle be calculated, they said by measuring the lengths of two sides and the angle in between. The full area could then be obtained. How can you get the angle? They said by using an instrument called the "survey triangle".

- However when the MVE team asked the local sample team to measure the angle on the selected field they failed to do it. The MVE team felt that the survey triangle tool was never used in area measurements in the selected fields.

- Some local sampling staff told the MVE team that they only measure the length and width of the selected field, and if the field shape is not rectangular, they said they just measured the four sides of the field and average the two lengths and the two widths and multiply the two averages to get the field area.

- Most of the selected fields were not well located, except those of the cotton forecasting fields. These difficulties stemmed from either confusing farmer names or hod names. In addition, quite a few clusters were reduced in size. This was noticeable in some governorates, where the clusters are very close to urban areas, eg. El Agami cluster (about 100 feddans only) at Qotour district in Gharbia, . Therefore, **it is very essential to establish or update the National Statistical Sampling Fram**e.

- In a few selected fields, which have very long lengths and narrow widths, the MVE team discovered that the local team just measured the width, while the lengths were calculated by dividing the prospective field area by the measured width. This was noticeable in Minya and Gharbia governorates.

- In Assuit and Dakahlia, the local team convinced the MVE team that all sides of the selected fields were measured.

4. DATA ANALYSIS AND DISCUSSION

4.1 Background

For sample survey designs, simple and stratified random sampling, cluster sampling, it is assumed that the data were correctly recorded and provided an accurate representation of the n elements sampled from the population. Under these assumptions, the population parameters were estimated accurately.

In this pilot survey, these assumptions were not fulfilled. First, the recorded measurements of the area estimation methods were not always accurate representations of the desired data because of biases of some of the interviewers or measuring equipments. Second, the existing statistical frame in each studied governorate is very old and not always complete nor accurate. Hence, the chosen sample might not have been selected from the complete population. Third, obtaining accurate sample data might be impossible because of the sensitive nature of the questions, interviewers or enumerators.

In this paragraph, the study used what is called the interpenetrating subsamples method as suggested by Scheaffer et al (1990) for analyzing data when measurement errors are presented or an inadequate frame is used.

Using the above mentioned technique, the sample in each governorate was divided into three subsamples in Lower Egypt governorates or two subsamples in Middle and Upper Egypt governorate based on the number of the major summer crops. Therefore, in each governorate in Delta, there were three subsample for area estimation of cotton, maize and rice crops. While in Minya and Assuit there were only two subsamples; one for cotton and the other for maize.

4.2 Statistical Analysis

A matched pair t-test was used to compare between the four methods of area estimation measurements that used in this study. That is, (1) Instrument measurement, (2) Tape measurement by sampling staff, (3) Farmer estimate, and (4) Extension agents' estimates. In addition, the ratio estimator was used for estimating the correction factor that will be recommended for agricultural extension data adjustment. There is an analogy between the ratio estimator and classical regression analysis. In the classical regression setting of infinite population, suppose the fitted model

$$E(y_i) = b \cdot x_i \qquad (1)$$

Since, y_i and x_i are two area measurements which were obtained from the same field using two different methods, it is expected that the variance of y_i is proportional to x_i. Then, a standard least squares weighted regression analysis with weights 1/xi will produce r as the estimator of b

SPSS- was used to estimate r crop wise in each governorate under the study.

4.2.1 Ratio Estimates of Cotton, Maize and Rice in Gharbia Governorate

Data analysis showed significant difference between new instrument, Visit and Sampling measurements against the agricultural extension data from maize subsample only. However; T-Paired test analysis showed significant difference between new instrument and Visit measurements against Sampling measurements in rice subsample. Hence, the study produced only the ratio estimates of the New instrument and visit against the extension data using the weighted regression analysis

Results of weighted regression analysis which are summarized in Table 2 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton, maize and rice respectively which were as follows:

$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN} \tag{1.1}$$

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN} \tag{1.2}$$

$$\hat{y}_{NEWINS} = 1.001 \cdot y_{EXTEN} \tag{1.3}$$

Table 2: The Estimated Coefficient of Cotton, Maize and Rice

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.942	.075	.967	12.510	.000	.776	1.108
2.00	1	EXTENSIO	.763	.055	.973	13.919	.000	.642	.884
3.00	1	EXTENSIO	1.001	.055	.984	18.046	.000	.879	1.123

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .154, .110 and .111 (1.4)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, maize and rice less than 0.16, 0.12 and 0.12 respectively. That is, the true correction ratio R for the population were between the following intervals:
95% C.I.= (0.78,1.11), (0.64,0.88) and (0.89,1.12), (1.5)

For cotton, maize and rice area estimation in Gharbia using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 3 showed the fitted regression equations of the sampling visit measurements on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{VISIT} = 0.97 \cdot y_{EXTEN} \quad (1.6)$$

$$\hat{y}_{VISIT} = 0.76 \cdot y_{EXTEN} \quad (1.7)$$

$$\hat{y}_{VISIT} = 1.004 \cdot y_{EXTEN} \quad (1.8)$$

Table 3: The Estimated Coefficient of Cotton, Maize and Rice

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.970	.082	.963	11.848	.000	.790	1.150
2.00	1	EXTENSIO	.760	.048	.979	15.756	.000	.654	.866
3.00	1	EXTENSIO	1.004	.058	.982	17.437	.000	.878	1.131

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .164, .094 and .110
(1.9)

The t-ratio and p-value and 95%confedence intervals in Table 3 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the standard errors of the estimates less than 0.17, 0.10 and 0.12 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.79,1.15), (0.65,0.87) and (0.89,1.13), (1.10)

For cotton, maize and rice area estimation in Gharbia using the new instrument measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired test analysis, however analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in

(1.5) were mostly shorter than the visit measurements method in (1.10). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Gharbia.

Therefore, the study recommended the following fitted equations in Gharbia

$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 1.001 \cdot y_{EXTEN}$$

For cotton, maize and ric e area estimation adjustment respectively

4.2.2 Ratio Estimates of Cotton And Maize In Minya Governorate

Data analysis applying “T-Pared test Statistic, showed significant difference between New instrument and Sampling measurements against the agricultural extension data from cotton subsample at 5% significant level. While, it showed the same results at 10% level in maize subsample. However, T-Paired test analysis showed no significant difference between new instrument, visit and sampling measurements . Hence, the study produced only the ratio estimates of the New or visit instrument and visit against the extension data using the weighted regression analysis

Results of weighted regression analysis which are summarized in Table 4 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN} \quad (2.1)$$

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN} \quad (2.2)$$

Table 4: The Estimated Coefficients of Cotto n and Maize

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			5% Confidence Interval for B	
CROP	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENTIO	.760	.050	.966	15.297	.000	.655	.864
2.00	1	EXTENTIO	.763	.083	.913	9.239	.000	.589	.937

a. Dependent Variable: NEWINSTR

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .10 and .166 (2.3)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, and maize less than 0.11 and 0.17 respectively. That is, the true correction ratio R for the population were between the following intervals:

95% C.I. = (0.66,0.86) and (0.59,0.94), (2.4)

For cotton and maize area estimation in Minya using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 5 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{VISIT} = 0.82 \cdot y_{EXTEN} \quad (2.5)$$

$$\hat{y}_{VISIT} = 0.79 \cdot y_{EXTEN} \quad (2.6)$$

Table 5:The Estimated Coefficient of Cotton and Maize

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			5% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.747	.052	.948	14.250	.000	.638	.855
2.00	1	EXTENSIO	.819	.050	.970	16.498	.000	.714	.924

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .114 and .156 (2.7)

The t-ratio and p-value and 95%confedence intervals in Table 5 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation were less than 0.12 and 0.16 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.69,0.94) and (0.63,0.96), (2.8)

For cotton, maize and rice area estimation in Minya using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired test analysis, however analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in (2.4) were mostly shorter than the visit measurements method in (2.8). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Minya.

Therefore, the study recommended the following fitted equations in Minya

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$$

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$$

For cotton and maize area estimation adjustment respectively

4.2.3 Ratio Estimates of Cotton and Maize in Assuit Governorate

Data analysis applying matched pair t-test statistic, showed significant difference between New instrument, Visit and Sampling measurements against the agricultural extension data from cotton subsample . While, it showed significant difference only for New instrument and Visit against the agricultural extension in maize subsample. However, T-Paired test analysis showed significant difference between Visit and sampling at 10% level of significance and no significant difference between new instrument and visit measurements. Hence, the study produced only the ratio estimates of the new instrument or visit against the extension data using the weighted regression analysis.

Results of weighted regression analysis which summarized in Table 6 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{NEWINS} = 0.73 \cdot y_{EXTEN} \quad (3.1)$$

$$\hat{y}_{NEWINS} = 0.87 \cdot y_{EXTEN} \quad (3.2)$$

Table 6: The Estimated Coefficients of Cotton and Maize

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	5% Confidence Interval for E Lower Bound	5% Confidence Interval for E Upper Bound
1.00	1	EXTENSIO	.734	.056	.940	13.169	.000	.619	.849
2.00	1	EXTENSIO	.870	.039	.984	22.517	.000	.789	.952

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .112 and .078 (3.3)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, and maize were less than 0.12 and 0.08 respectively. That is, the true correction ratio R for the population were between the following intervals:

95% C.I. = (0.62,0.85) and (0.79,0.95),
(3.4)

For cotton, maize and rice area estimation in Assuit using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 7 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{VISIT} = 0.75 \cdot y_{EXTEN}$$
(3.5)

$$\hat{y}_{VISIT} = 0.82 \cdot y_{EXTEN}$$
(1.6)

Table 7: The Estimated Coefficient of Cotton and Maize

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	5% Confidence Interval for E Lower Bound	5% Confidence Interval for E Upper Bound
1.00	1	EXTENSIO	.747	.052	.948	14.250	.000	.638	.855
2.00	1	EXTENSIO	.819	.050	.970	16.498	.000	.714	.924

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .104 and .100
(3.7)

The t-ratio and p-value and 95%confedence intervals in Table 7 showed that, in the infinite normal population setting, the regression coefficient were significantly different from zero. Hence, we are quite confident that the errors of the estimation were less than 0.11 and 0.11 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.64,0.86) and (0.71,0.92),
(3.8)

For cotton and maize area estimation in Assuit using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the matched pair t-test analysis, however analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in (3.4) were mostly shorter than the visit measurements method in (3.8). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Assuit.

Therefore, the study recommended the following fitted equations in Assuit

$$\hat{y}_{NEWINS} = 0.73 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.87 \cdot y_{EXTEN}$$

For cotton and maize area estimation adjustment respectively

4.2.4 Ratio Estimates of Cotton, Maize and Rice in Behira Governorate

Data analysis applying matched pair t-test statistic, showed significant difference between New instrument, Visit and Sampling measurements against the agricultural extension data from cotton subsample. Also there was significant difference between Visit and sampling under the subsample of cotton. However; T-Paired sampled tests showed no significant difference between all methods measurements in maize and rice subsample. Hence, the study produced only the ratio estimates of the New instrument and visit against the extension data using the weighted regression analysis

Results of weighted regression analysis which are summarized in Table 8 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{NEWINS} = 0.78 \cdot y_{EXTEN} \tag{4.1}$$

$$\hat{y}_{NEWINS} = 0.88 \cdot y_{EXTEN} \tag{4.2}$$

$$\hat{y}_{NEWINS} = 0.96 \cdot y_{EXTEN} \tag{4.3}$$

Table 8: The Estimated Coefficients of Cotton, Maize and Rice

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.783	.048	.973	16.379	.000	.681	.885
2.00	1	EXTENSIO	.877	.110	.893	7.939	.000	.643	1.111
3.00	1	EXTENSIO	.961	.082	.950	11.768	.000	.787	1.135

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .096, .220 and .164 (4.4)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficient were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, maize and rice were less than 0.16, 0.12 and 0.12 respectively. That are, the true correction ratio R for the population were between the following intervals:

95% C.I.= (0.68,0.88), (0.64,1.11) and (0.79,1.13), (4.5)

For cotton, maize and rice area estimation in Behira using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 9 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{VISIT} = 0.79 \cdot y_{EXTEN} \qquad (4.6)$$

$$\hat{y}_{VISIT} = 0.85 \cdot y_{EXTEN} \qquad (4.7)$$

$$\hat{y}_{VISIT} = 0.94 \cdot y_{EXTEN} \qquad (4.8)$$

Table 9: The Estimated Coefficients of Cotton, Maize and Rice

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.789	.046	.975	17.025	.000	.690	.888
2.00	1	EXTENSIO	.846	.109	.889	7.786	.000	.616	1.076
3.00	1	EXTENSIO	.943	.087	.942	10.883	.000	.758	1.127

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .092, .218 and .174
(4.9)

The t-ratio and p-value and 95%confedence intervals in Table 10 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the standard errors of the estimates less than 0.10, 0.22 and 0.18 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.69,0.89), (0.62,1.08) and (0.76,1.13), (4.10)

For cotton, maize and rice area estimation in Behira using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired sample test analysis. However, analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in (4.5) were mostly shorter than the visit measurement method in (4.10). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Behira.

Therefore, the study recommended the following fitted equations in Behira

$$\hat{y}_{NEWINS} = 0.78 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.88 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.96 \cdot y_{EXTEN}$$

For cotton, maize and rice area estimation adjustment on the agricultural extension data obtained from the agricultural Departments on the district under the study:

4.2.5 Ratio Estimates of Cotton, Maize and Rice in Dakahlia Governorate

Data analysis applying "T-Pared sampled test, showed significant difference between New instrument, Visit and Sampling measurements against the agricultural extension data from cotton subsample. There was no significant difference between New Instrument, Visit and Sampling methods under the subsample of cotton. However; T-Paired sampled tests showed no significant difference between New Instruments and Visit methods measurements in maize cotton subsample, as well as between Sampling and Extension in maize and rice. But there was significant difference between New Instruments and Visit methods under rice subsample. Hence, the study produced only the ratio estimates of the New instrument and visit against the extension data using the weighted regression analysis.

Results of weighted regression analysis which summarized in Table 10 showed the fitted regression equations of the new instrument measurement on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{NEWINS} = 0.89 \cdot y_{EXTEN} \quad (5.1)$$

$$\hat{y}_{NEWINS} = 0.92 \cdot y_{EXTEN} \quad (5.2)$$

$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN} \quad (5.3)$$

Table 10: The Estimated Coefficients of Cotton, Maize and Rice

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1.00	1	EXTENSIO	.891	.040	.978	22.387	.000	.809	.973
2.00	1	EXTENSIO	.919	.028	.993	32.855	.000	.859	.978
3.00	1	EXTENSIO	.935	.061	.969	15.273	.000	.804	1.065

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .080, .056 and .122 (5.4)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, maize and rice were less than 0.09, 0.06 and 0.13 respectively. That is, the true correction ratio R for the population were between the following intervals:

95% C.I.= (0.81,0.97), (0.86,0.98) and (0.80,1.06),
(5.5)

For cotton, maize and rice area estimation in Dakahlia using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 11 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{VISIT} = 0.91 \cdot y_{EXTEN} \quad (5.6)$$

$$\hat{y}_{VISIT} = 0.93 \cdot y_{EXTEN} \quad (5.7)$$

$$\hat{y}_{VISIT} = 0.96 \cdot y_{EXTEN} \quad (5.8)$$

Table 11: The Estimated Coefficients Of Cotton, Maize And Rice

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	5% Confidence Interval for Lower Bound	5% Confidence Interval for Upper Bound
1.00	1	EXTENSI(	.913	.030	.988	30.467	.000	.851	.975
2.00	1	EXTENSI(	.929	.032	.991	29.006	.000	.860	.997
3.00	1	EXTENSI(	.961	.063	.969	15.199	.000	.827	1.096

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .06, .064 and .126
(5.9)

The t-ratio and p-value and 95%confedence intervals in Table 11 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the standard errors of the estimates less than 0.07, 0.07 and 0.13 respectively. That is, the true correction ratio R for the population were between

$$95\% \text{ C.I.} = (0.85,0.98), (0.86,1.00) \text{ and } (0.83,1.10), \qquad (5.10)$$

For cotton, maize and rice area estimation in Dakahlia using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired sample test analysis, except in rice subsample there was significant difference between New Instrument and Visit methods. Analysis of regression also, showed that, the 95% confidence intervals of the ratio estimates of new instruments in 51.5) were mostly shorter than the visit measurement method in (5.10). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Dakahlia.

Therefore, the study recommended the following fitted equations in Dakahlia

$$\hat{y}_{NEWINS} = 0.89 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.92 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$$

For cotton, maize and rice respectively for area estimation adjustment on the agricultural extension data obtained from the agricultural Departments:

4.3 Summary

Data analysis showed significant difference between the New Instrument, Sampling staff and Visit methods against the Extension data in all governorates under study and in almost all crops under study. The exceptions were a few cases in Gharbia, where there were no significant differences. However; matched pair t-test analysis showed significant differences between the new instrument and Visit measurements against the Sampling measurements in some crops under the study.

The results of weighted regression analysis showed that the fitted regression equations of the New Instrument measurement on the agricultural extension data, for almost all the major summer crops under study, were more efficient in reducing the estimates errors bound. The 95% confidence intervals of the ratio estimates of New Instruments for almost all crops were shorter than that of the Visit measurement method. Thus, the ratio estimates (correction factors) obtained from the New instruments were more efficient to use in crop area estimation and are recommended. The fitted equations of the weighted ratio regression for cotton, maize and rice as well as the total crop area obtained from the agricultural department before adjustment and after adjustment are summarized in Table 12.

Table 12: Crop Area Estimates Adjusted by Weighted Ratio Estimate using New Instrument Measurements, 2001

(1000 feddans)

Governorate, crops	Standard Weighted Ratio Model	Extension data y_{EXTEN}	Estimated y_{NEWINS}	%
Gharbia	$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$			- 6
cotton	$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$	58	45	- 24
maize	$\hat{y}_{NEWINS} = 1.001 \cdot y_{EXTEN}$	231	176	+0 .1
rice		141	142	
Minya				- 24
cotton	$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$	34	26	- 24
maize	$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$	30	23	
Assuit				
cotton	$\hat{y}_{NEWINS} = 0.73 \cdot y_{EXTEN}$	32	24	- 27
maize	$\hat{y}_{NEWINS} = 0.87 \cdot y_{EXTEN}$	82	71	- 13
Behira				
cotton	$\hat{y}_{NEWINS} = 0.78 \cdot y_{EXTEN}$	160	125	- 22
maize	$\hat{y}_{NEWINS} = 0.88 \cdot y_{EXTEN}$	163	144	- 12
rice	$\hat{y}_{NEWINS} = 0.96 \cdot y_{EXTEN}$	205	196	- 4
Dakahlia	$\hat{y}_{NEWINS} = 0.89 \cdot y_{EXTEN}$			
Cotton		93	82	- 11
maize	$\hat{y}_{NEWINS} = 0.92 \cdot y_{EXTEN}$	100	92	- 8
rice	$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$	395	371	- 6

Results in Table 6.1 indicate that agricultural extension data are an overestimation ranging from 4% to 27% for the planted areas of the major summer crops except for the rice area estimation in Gharbia, which had a downward bias of 0.1 %.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the above discussion and results of matched pair t-test and weighted regression analysis, the study concludes that the New Instrument and Visit measurement and there was no significant differences between New Instrument and Visit measurements for most of the crops. However, in most of the cases the 95% confidence intervals using the New Instruments were shorter than that of the Visit method. Hence, it is concluded that the New Instrument was more efficient than all other measurement methods.

5.2 Recommendations

- Apply the proposed method, including the new instruments, in one or more governorates.
- Use the surveying level instrument with fixed hair stadia method to perform easy, quick and accurate results.
- Continue applying the proposed procedure annually in order to derive the correction factor for crop area estimation adjustment to the extension agent estimates studied governorates.
- The staff members need a comprehensive training course in how to use the new instruments in measuring lengths and angles, and how to plot their traverses.

Suggested Training Program

Time	Class	Subject
2 hrs	Lecture	General rules for measuring distances
3 hrs	Training	Taping and chaining using alignment method
2 hrs	Lecture	General rules for measuring angles
3 hrs	Training	Magnetic compass for measuring direction and internal angles.
2 hrs	Lecture	Theodolite: theory and its components. Tachometric process for measuring distances.
4 hrs	Training	How to use Theodolite for measuring distances and angles (vertical and horizontal).
2 hrs	Lecture	Surveying level, theory and its application to measure distances and angles.
4 hrs	Training	How to use surveying level.
2 hrs	Lecture	Planimeter theory for measuring maps area of curved shapes
4 hrs	Training	How to use the planimeter for measuring area of maps

6 hrs	Training	Project Perform real field work estimating the area of different shapes and plotting its sketches with respect to the internal angles and direction. Learn how to correct any fieldwork using closing correction method.

N.B.

- In training there should not be more than 4 trainees per instrument.
- The program needs one professor to give, lectures and supervise the training classes, and one demonstrator for each instrument.

REFERENCES

Koshel, R., S. **Estimation of Area under Principle Crops, Ministry of Agriculture, Egypt.** 1962.

FAO Publication. **Estimation of Crop Areas and Yield in Agricultural Statistics.** Rome, 1982.

USDA. **Scope and Methods of the Statistical Reporting Service, M., P., No.1308.** Washington, D.C. 20250, 1983.

Fawzy, M., A., *et al.* **Availability and Quality of Agriculture Data in Egypt.** MVE Unit/APRP. Egypt, 1998.

EAS. **A Pilot Study To Verify The Cotton Area Data.** Ministry of Agriculture, Egypt, 2000.

Mubarak, R., M. **Improvement of Agricultural Crops Area Statistics in Egypt.** AERI, ARC, Egypt, 2001.

ANNEX

VOLUME II: WINTER CROPS AREA ESTIMATION

Morsy Aly Fawzy
Abdallah Zein El-Din
Ramzy Mubarak
Mahmoud Abdel Fattah

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGMENTS

The authors would like to acknowledge the wise guidance and scientific advice of Dr. Saad Nassar. Appreciation is also extended to Eng. Mahmoud Nour for his strong support during the study implementation. Special thanks go to Dr. Mohamed Omran for the long discussions, feedback, and his participation in designing and implementing this study. The authors are greatly indebted to Dr. Gary Ender Chief of Party of the MVE Unit for his guidance, participation and support in formulating and implementing this report.

Appreciation should be extended to Eng. Mohamad El Shahed, the head of the Economic Affairs Sector. Without his cooperation and assistance, this study would never have been completed. Appreciation is also extended to Eng. Abd El Razik Hassan, the head of the Central Administration of Agricultural Economics and Eng. Saed El Agaty, the Head of the Sampling Department, for their full support and cooperation.

The authors also would like to acknowledge the hard work and dedication of the researchers who conducted the field investigations: Eng. Mohamed El Sayed Abed, Sayed Gad El Moula, Abdel Hameed Mokhtar, and Ahmed El Kenany.

Appreciation is also extended to Dr. Ahmed Omran, Eng. Mohamed Ibrahim and Eng. Mohamed Taha from the Faculty of Agriculture in Alexandria University. Special thanks also go to Mr. Salah M. Arafa for his hard work in handling the data on the computer.

Special thanks go to Mrs. Yvonne Louis for her hard work in data entry, tabulation, and file manipulation.

Finally, any errors and omissions should be attributed to the authors and not to the APRP, USAID, or MALR.

EXECUTIVE SUMMARY-WINTER CROPS

To estimate or forecast the volume of production of the main field crops, accurate data are needed for both yield and crop area. The MVE Unit-APRP collaborated with MALR/EAS on some activities regarding yield forecasting, but until recently, not on crop area estimation. It is essential to have a clear understanding of the availability and quality of crop area data, because these data are used to document the growth rate of production and to study the impact of agricultural policy on these crops. This is important both for MVE's impact assessment in general and for policy makers in Egypt as well.

The main **objectives** of this study were to:

- Assess the availability and quality of agricultural data for the area of major winter crops, namely, wheat, berseem, fava beans and onions, in the selected governorates (Behira, Gharbia, Dakahlia, Sharkia, Menia and Assiut)

- Estimate the main winter crops area using newly purchased, modern equipment and train the EAS staff in using it in the selected governorates

- If possible, propose an advanced objective methodology and sampling procedures to forecast the expected area of summer crops at the time of measuring the winter crops area

The objectives mentioned above were achieved by conducting a check-sample survey of area in conjunction with crop-cutting surveys.

Sample. The plan was to select two districts within each governorate and two clusters (200 feddan in average), within each district. In each cluster four parcels growing wheat were selected randomly, in addition to two berseem and two fava beans or two onions if found in the cluster. The total sample was 96 wheat parcels, 72 berseem, 18 fava beans and 6 onion.

Data collection. New forms for data collection were developed, and an area survey was conducted during about three weeks (23 March - 11 April 2002).

Survey procedures. The area under each parcel was estimated by four methods:
(a) directly measured by the MVE team using a modern optical instrument, (b) sampling staff measurements during their visit using a tape on the ground, (c) inquiry from the local extension staff in the village, (d) farmer's estimate for his crop area. These area data were compared with each other by applying statistical analysis. Other information about summer crop forecasting was collected from farmers and local staff.

Data processing. The data were carefully checked and reviewed, and field areas were computed. All of the collected data were submitted to the EAS.

Training. On-the-job training for about 80 sampling staff was conducted. About 25 were trained in using the new instruments, and the others were trained in using tape, survey data collection. An advanced training course was held for those trainees in area measurements and calculations.

Evaluation of crop area estimates. The check-sample technique using the new optical instrument proved that the subjective methods based on inquiry by extension agents or farmers' data overestimate crop areas and need to be adjusted by check sample, while tape measurements were relatively close to instrument measurements. The calculations of t- test in pairs, the root mean squared error (RMSE), average absolute percentage error (AAPE) and errors directions confirm these results.

Winter crops area estimation. To adjust and correct the crop area estimates by extension staff and to remove bias, ratio estimate and regression estimate were successfully used to obtain area estimates with the acceptable levels of sampling error at both governorate and total sample levels.

Optimum sample size. Based on the nested analysis of variance components and using ratio estimates, the optimum sample size was obtained. By sampling about 20 clusters with four fields per cluster, it is possible to estimate crop area with a sampling error approaching 3% at the governorate level. The study included tables for different levels of precision and different numbers of fields that should be selected within clusters.

Forecasting of area under summer crops 2002. The study demonstrated the possibility of using farmers' planting intentions survey to forecast the expected summer season crop area. Using data from the indicative and actual cropping patterns in the selected villages also gave good results.

Recommendations. The team's recommendations can be summarized as follows:

- Use a check sample to improve crop area estimation
- Apply this method in more governorates
- Increase the sample size depending on the optimum sample size calculation
- Purchase more optical instruments, compasses and metallic tapes
- Sampling staff need more on-the-job training
- Conduct further research for crop area estimation improvements
- Establish a specialized unit for area estimation

1. INTRODUCTION

1.1 Background

Area as well as average yield per feddan is the two main factors for the estimation of the agricultural production of specific crop. There are two methods of estimating area under crops in Egypt: (1) The subjective method, which is based on the village extension staff inquiry from the farmers, (2) the objective method, which is based on direct measurement on the ground for main crops. The first method is carried out for all crops, while the second method is confined to main crops only such as: wheat, cotton, and paddy. These methods are linked with the cadastre maps and register of rights. It should be mentioned that the second method stopped by 1999-2000.

The country is divided into 26 Governorates (each one is called Mohafza), each governorate consists of a number of districts, each district has villages, each village contains one or more than one " hode" (a hode is compact irrigated basin of land of about 50-100 feddan with few exceptions) which is defined on maps and on the ground by natural boundaries. Each hode is subdivided into smaller pieces of land representing the property lines of the owners of land. Over years the fragmentation of ownership takes place and the demarcation signs change on the ground accordingly, which consequently means that the new property lines should be drawn on new maps. Each holder is asked to keep small booklet (named hiyaza card), where the areas under different crops grow in the course of one agricultural year on the holding, is entered.

For the estimation of area by inquiry (first method), the local agricultural staff collectors in each village should be informed by farmers in each hode about the areas of different crops grown spot inspection. This information based on inquiry from the farmers is therefore subject to large and indeterminate bias.

1.2 Objectives of the Study

The main objectives of the study are:

- Assess the availability and quality of agricultural data for the area of major winter crops, namely, Wheat, Berseem, Fava Beans, and Onions in the selected Governorates.
- Estimating crop area by newly and modern instruments and train the EAS staff in using it in the selected Governorates (Behira, Dakahlia, Gharbia, Sharkia, Menia and Assuit).
- If possible, propose an advanced objective methodology and procedures to estimate the expected area of the summer crops at the time of measuring the winter area.

1.3 Main Concepts And Definitions

1.3.1 Error Definition

On the basis of the concept of the adopted fieldwork system, the concept of true value can be defined. The true value is simply the result that should be obtained in a particular survey operation if the adopted system of work is carried out correctly. There are several types of true value. The first one is the individual true value of a characteristic for a given unit of a population. The true value of the total area of a holding as expressed in feddan (unit area) would be the sum of the true values of the area of individual fields. In addition to individual true values there is a true values of totals, averages, proportions, ratios, coefficients of correlation and other statistical measures. By means of the true values and the survey value we could define the error as the difference between the survey value and the corresponding true value.

1.3.2 Frequency Distribution of Individual Errors

Frequency distribution of error has drawn a relatively great attention from the practical point of view. If both positive and negative errors are distributed at random around zero, the estimates of totals and averages will be unbiased. In many cases, however, there is some pattern in errors distribution in the sense that either positive or negative errors are pre-dominated. In such a case there is a systematic errors. Therefore, totals and averages based on data subject to systematic errors will normally be biased.

1.3.3 Bias Definition

The bias is the net effect of all errors. The magnitude of the bias and its sign do not have equal importance in all the studies. Users of data will primarily be interested in the magnitude of the bias. In some analyses of errors, however, the sign of the bias may become more important.

1.3.4 Accuracy Checks

Some difficulties in defining aims and purposes of quality checking are connected with the interpretation of data collected in the check process itself. These data are used to judge the quality of the original survey. Obviously, before any statement regarding the original survey can be made, an agreed upon criterion for evaluation must be established. Hence, the question of the quality of data collected in the check sample can be assessed. In the ideal case, check data would represent true values. In this case the check provides estimates of bias and the mean square errors. However, accuracy checks are not practically impossible as it is sometimes claimed. There are some fields of statistical work where there is no serious difficulty in getting these true values. Examples of those are the ones, which are based on measurements, such as area measurements and crop weighing.

1.3.5 Accuracy Level of Methods

1. The Root Mean Square Error (R.M.S.E)

$$RMSE = \left[\frac{\sum_{i=1}^{n} \left(F_i - A_i \right)^2}{n} \right]^{\frac{1}{2}} \qquad (1)$$

Where: Fi : crop area measured by tape or extension or farmer for subject i
Ai : crop area measured by instrument for subject i
n : Sample size.

2. Size of Average Absolute Percentage Error (A.A.P.E)

$$AAPE = \sum_{i=1}^{n} \left| \frac{F_i - A_i}{n} \times 100 \right| \qquad (2)$$

Outliers could affect these formulas, thus we have to exclude these values or use another procedures.

1.3.6 Ratio Estimate Method

$$\mathbf{R_C} = \frac{\overline{\mathbf{Y}}}{\overline{\overline{\mathbf{X}}}}$$

Where R_C is the combined ratio

$$\overline{\mathbf{Y}} = \frac{\mathbf{1}}{\mathbf{n}} \sum \mathbf{y_i}$$

Y_i: area of sample n measured by instrument for the crop.
X_i : area of sample n measured by other methods for the crop

$$\hat{\mathbf{Y}}_{\mathbf{R_C}} = \mathbf{R_C X}$$

Where: $\hat{\mathbf{Y}}_{\mathbf{R_C}}$: total area estimate of the crop
R_c : combined ratio estimate from check sample
X : total area by inquiry method (extension)

The variance formula is given by:

$$\mathbf{v(\hat{y})} = \frac{\sum \mathbf{N_i(N_i - n_i)}}{\mathbf{n_i(n_i - 1)}} \left[\sum (\mathbf{y_{ij}} - \overline{\mathbf{y}}_\mathbf{i})^2 + \mathbf{R_c^2} \sum (\mathbf{x_{ij}} - \overline{\mathbf{x}}_\mathbf{i})^2 - \mathbf{2R_C} \sum (\mathbf{y_{ij}} - \overline{\mathbf{y}}_\mathbf{i})(\mathbf{x_{ij}} - \overline{\mathbf{x}}_\mathbf{i}) \right]$$

1.3.7 Regression Estimate Method

$$\hat{\mathbf{Y}} = \overline{\mathbf{Y}} + \mathbf{b}(\mathbf{M_X} - \overline{\mathbf{X}})$$

$$\mathbf{b} = \frac{\sum (\mathbf{x_i} - \overline{\mathbf{x}})(\mathbf{y_i} - \overline{\mathbf{y}})}{\sum (\mathbf{x_i} - \overline{\mathbf{x}})^2}$$

Where:

b : Regression coefficient from the Check-Sample
$\overline{\mathbf{y}}$: Average of field area measured by instrument in the sample
$\overline{\mathbf{x}}$: Average of field area by inquiry of extension in the sample
M_x : Average of field area by inquiry of extension in the population
$\hat{\mathbf{Y}}$: Average of field area estimated

The formula of the variance estimated is given by:

$$\mathbf{v(\hat{M}_{yL})} = \frac{\mathbf{N - n}}{\mathbf{N_n}} \times \frac{\mathbf{1}}{\mathbf{n - 2}} \left[\sum (\mathbf{y_i} - \overline{\mathbf{y}})^2 - \mathbf{b^2} \sum (\mathbf{x_i} - \overline{\mathbf{x}})^2 \right]$$

1.3.8 Sample Size Determination

The Variance of the mean (using this equation) is given by:

$$\mathbf{v}(\hat{\mathbf{y}}) = \frac{\mathbf{S_b^2}}{\mathbf{n}} + \frac{\mathbf{S_w^2}}{\mathbf{nm}}$$

Where: $\mathbf{S_b^2}$: The variance component estimated between clusters

$\mathbf{S_w^2}$: The variance component estimated between fields within clusters

n : The total number of cluster selected in the sample.

m : the number of fields selected in each cluster.

From equation (1)

$$\frac{\mathbf{S_b^2 / n + S_w^2 / nm}}{\bar{\mathbf{y}}^2} = \frac{\mathbf{t^2}}{(\mathbf{100})^2}$$

Where: $\mathbf{t}$: standard error percentage levels

$\bar{\mathbf{y}}$: Sample average.

Thus one can establish a table for number of clusters **n** for given number of field's-m within cluster for different levels of precision **t** (S.E%)

2. ASSESSMENT OF EXISTING METHODS

2.1 Description

The area under wheat and cotton have been estimated since 1957 and 1958; respectively, on the basis of a sample census involving measurement of area by a *kassaba* (a pole 3.5 meters long) in 50% of the cultivated land in Egypt. Therefore, the cultivated land in each district was divided into clusters of about 2000 feddans (range: 1500-2500 feddans) by combining adjacent villages or splitting big villages. About 50% of these clusters were randomly selected in each district for its area to be measured by the survey department. The area estimates were obtained by the combined ratio estimate method. The main defects of estimating the crop area by this method are:

- Cadastre maps (scale 1/2500) must be renewed because of the change of fiscal boundaries and topographical features.
- Inaccurate measurement because of using the kassaba.
- The surveyor may leave out some areas without marking.
- Small patches under minor crops and vegetables may be included as area under the principal crops to be estimated.
- Large drains, channels, bounds …etc may be included as area under the crop.
- Faults of sketching on the cadastre maps and measuring the area by planimeter.

The following section includes the detailed history of the crop area estimation in Egypt.

2.2 Subjective Method

For the estimation of area by inquiry (first method), started by the tax collector (sarraf) in each village with the help of his register (Garida), who should know the ownership of areas and their distribution among holders within his financial zone (village). The sarraf for the purpose of collecting the government taxes on the cultivated land, should be informed by the holder about the areas of different crops grown in his holding. This information based on the inquiry from farmers is therefore subject to large indeterminate bias. Even though the cultivated area of the village (Zimam) is known to the sarraf on his main interest for collecting money, the distribution of this area for different crops within the village as dictated by the farmer himself will be sometimes misleading. The areas under major crops obtained by this method are compared with the corresponding total area obtained by the Egyptian Survey Authority (ESA). More than 5% different has been found, corrections are made in the forms by repeated inquires. The estimation of area by inquiry continued till recently but conducted by agricultural extension agents in the village under the supervision of Agricultural Affairs Departments, and still related to subjective effects.

2.3 Objective Method

Before 1956. The area under main crops (Wheat, Cotton, and Paddy) was obtained every year by complete enumeration on the ground and is carried out by the ESA staff with the help of detailed maps of hodes (several maps for each village). The area under the crop is measured on the ground by *kassaba*, then drawn on maps of the scale 1/2500 size 40 cm × 60 cm, representing 1 km × 1.5 km of area. One or more hodes mapped with properly lines and topographic features. The computation of area is done by planimeter at the computation office at Cairo, in several stages.

The above census method, which was based on measurements on the ground by kassaba, subsequent markings on the cadastre maps, and finally computing the area by planimeter, was a very expensive method of obtaining areas under crops. As it is already known in all censuses, there were defects such as: (1) some areas may be left out, (2) minor crops and vegetables and large drains, channels, bonds …etc. may be included as area under the measured crop, (3) inaccurate measurements due to the used tool or kassaba, (4) faults of sketching on the cadastre maps and measuring the area by planimeter.

Check Sample on Area under Crops, 1956. Check-Sample on area under cotton was conducted in Sohag province in 1956. In all 103 clusters of crop cutting distributed in the ten districts using. (a) Tape and triangulation. (b) Tape and planimeter. The results were that in almost all censuses there were large and indeterminate bias of the enumerators, and one of the possible solutions is to conduct a check-sample every year to correct them. For this purpose they used two methods as compared with the complete enumeration. The main results were that both Ratios and Regression estimates had given smaller sampling error (1.56, 1.48 S.E %) as compared with the mean per unit estimate (5.1 S.E%). Therefore, it was recommended to use the method of ratio estimation, which has also simpler computation process. A comparison of the census figures with the sample estimates of gross area showed that the census figure was under estimated by 4.5%.

1957–1999. As it should be noticed, the ESA method of obtaining crop areas by complete enumeration and measurement on the ground was very expensive, and hence; it was necessary to develop a sampling techniques of partial enumeration in order to reduce costs and efforts. The area under wheat since 1957 and the area under cotton since 1958 have been estimated on the basis of a sample involving measurement of area by a kassaba in 50% of the cultivated land in Egypt. For this purpose the cultivated land in each district was divided into clusters of about 200 feddans. The area under cotton is estimated by the ratio-estimate method using the highly correlated relationship between area in the year of estimation and the base year. The results demonstrated that 25% of the sample is sufficient to estimate the area under cotton for the whole country with ½ % sampling error, while a precession of 1 to 2 percent was obtained between province.

Since 1990 many problems faced the use of objective method such as: 1) the last base year (1961) became out of use. 2) Problems considering the budget about 3-4 millions/year. 3) The cadastre maps became too old without any renewing. Therefore, the crop area estimates were based on ratio estimates to adjust the estimates of inquiry by the sample measured by the ESA. However, the agriculture year 1999/2000 was the last year for using the ESA area measurements.

2000 and After. The subjective methods based on inquiry by agricultural extension staff became the only method for crop area estimate, therefore; the check-sample on area under main crops is one of the potential methods to be used in order to release the indeterminate bias of this subjective method.

In summary, the method of obtaining each crop area on the basis of sample survey involving measurement of area by *kassaba* in 50% of the cultivated land in Egypt is very expensive. The Ministry of Agriculture and Land Reclamation (MALR) decided to stop using this method since the year 2000, and tried to find more accurate and less expensive technique to be adopted. The new developed technique is based on check-sample of the area conducted by subjective methods of agricultural local staff to release its bias.

3. PROPOSED METHOD

The problems mentioned earlier concerning crop area estimation can largely be solved by conducting a check sample (CS) of area in conjunction with the crop-cutting surveys. A sample survey on wheat area was conducted by MVE/APRP in April 2002 in six governorates: Beheira, Gharbeya, Daqahleya, Sharqeya, in Lower Egypt, Minya and Assiut in Upper Egypt. In this survey the field work for CS on wheat area was confined to some of the clusters selected for crop-cutting experiments, which is also used for wheat yield forecasting. That is a multipurpose sample survey was carried out to serve crop-cutting experiments, short-term yield forecasting, and crop area estimation. The procedure is to select two districts within each governorate, two clusters (200 feddans agricultural land each on average) within each district. In each cluster four wheat parcels are randomly selected out of all parcels growing wheat in the cluster, two berseem parcels; two fava bean or onion parcels also are selected in the same manner. The total sample size checked is 96 wheat parcels, 72 berseem parcels, 18 fava bean parcels and 6 onion parcels. Table (1) shows the sample size and its distribution in this survey.

The area under each crop parcel of the sample is directly measured by: (a) the modern instruments, (b) sampling staff technique applying the tape on the ground, with the area calculated by the usual method of triangulation. In addition, the enumerators have been requested to measure the area occupied by dikes, channels, drains, etc., in order to provide the necessary corrections to the gross area and obtain the net crop area. A sketch was drawn for every sample observation measured by both methods includes all available information (see Appendix). In order to estimate the magnitude of bias and its direction for the subjective method, which is based on the inquiry from the farmer by the local extension agents, it can be verified either from the agricultural unit or the farmer.

This pilot study of the check sample of winter crops area was conducted in the selected six governorates during the period 22/3-10/4/2002 by about 80 sampling staff who got intensive on the job field training by MVE experts. In addition, about 36 of them received an advanced training course, which was held in Menia governorate, for drawing area sketching and calculations. There is currently, in every selected governorate, at least four well trained sampling staff who can apply the modern instruments in crop area estimation and at least eight well trained using tape for the same purpose.

As mentioned, one of the main purposes of the survey is to forecast the area of major summer crops such as cotton, rice and maize, which was done by using:(a) the farmers' planting intention farmer survey, (b) the relationship between winter and summer crops area within crop rotations, (c) the relationship between target and actual areas for main crops in successive seasons.

Table 1: Sample Distribution of Winter Crops Area by Check -Sample, 2002

Governorate	District	Village (Cluster)	Wheat	Berseem	Fava Beans	Onion	Total
Beheira	Damnhor	Kapeal	4	2	2	0	8
		Nediba	4	2	2	0	8
	Delingat	Atlemes	4	2	2	0	8
		Teba	4	4	0	0	8
Gharbeya	Tanta	Ramlia	4	2	0	2	8
		Shabsher	4	2	0	2	8
	Zefta	Aisha	4	2	2	0	8
		K. Naway	4	4	0	0	8
Daqahleya	Belkas	Masarah	4	2	2	0	8
		Belkas	4	2	2	0	8
	Agga	B. Elnour	4	4	0	0	8
		Garrah	4	2	0	2	8
Sharqeya	Zagazig	Tahra	4	2	2	0	8
		Shobak. B	4	2	2	0	8
	Diarb-Negm	Hawaber	4	2	2	0	8
		Shobra sora	4	2	2	0	8
Minya	Menia	Talla	4	4	0	0	8
		Towa	4	4	0	0	8
	Malawi	O.Kommos	4	4	0	0	8
		M.maghalka	4	4	0	0	8
Assiut	Assiut	Olwan	4	4	0	0	8
		Bora	4	4	0	0	8
	Dierot	Seregna	4	4	0	0	8
		peblaw	4	4	0	0	8
Total			**96**	**70**	**20**	**6**	**192**

Source: MVE/APRP Sample Survey, April 2002.

4. FIELD TEST OF THE PROPOSED METHOD

4.1 Institutional Functions

The Economic Affairs Sector (EAS), through its Central Administration for Agricultural Economics (CAAE), is the main organization responsible within the Ministry of Agriculture and Land Reclamation (MALR), for collecting and publishing agricultural statistics on area, yield and production. [Carrying out surveys to determine crop area at the village level is based on the agricultural extension agents estimates]. The Sampling Office in each governorate, with branch offices in some districts, conduct crop-cutting surveys to determine crop yield, and the sampling office's staff conducts and supervise the fieldwork. Beside the main work of crop–cutting, they are requested to check the crop area in conjunction with the crop-cutting sample only for wheat among the winter crops. No effort was made to check the area under other winter crops. The majority of the sampling staff have received little or no training in area check sampling.

In the selected fields within clusters, the area was directly measured by two methods on the ground:(1) modern optical instruments, (2) using the tape, with the area was calculated by the traditional methods of triangulation. In order to estimate the bias due to subjective inquiry, the surveyors were requested to obtain extension staff data and ask farmers about the area under their crops in the selected sample. Furthermore, the area under the crop includes varying amounts of uncultivated land (bonds, channels, drains) depending upon the topography of the land, and methods of cultivation. The net area after applying these corrections should be used as an expansion factor in conjunction with the yield rate determined by crop-forecasting or crop-cutting experiments for estimating total production.

4.2 Sampling Technique

A stratified multistage cluster random sampling design is used to select the crop cutting survey sample. Estimates of yields per feddan and total production, especially for wheat, are needed with high precision at the governorate level for formulating the appropriate agricultural policy and improve farmers' welfare. Within each governorate, the sample is allocated at the district level as strata.

Sample frame consists of primary sampling units namely clusters; the size of cluster is about 200 feddans of cultivated land (range 150 to 250 feddans). Combining hodes or divide big hodes within the same stratum forms clusters. The same frame of clusters is used for major seasonal crops throughout the year. Within each stratum, a certain number of sampling units or plots is selected in four stages:

- Selection of appropriate number of clusters randomly (2-5% of the population) depending upon the precision required.

- Two parcels growing wheat (4 in case of forecasting) are randomly selected out of all parcels growing the crop.
- Selection of one field within each selected parcel.

- The final stage consists of selecting a pair of random numbers for locating the plot of prescribed dimensions (2m×2m) for crop cutting or two adjacent plots of 60cm×60 cm in the case of wheat forecasting within the selected field.

Then area under wheat in the selected cluster is listed by parcels or field farmer's names and summarized. The secondary sampling units, which are about three feddans in size each, are formed in the selected cluster in case of parcels exceeds five feddans, it is divided into three sub-units and one of the divisions is selected. The sampling frame materials are out of dates. Having access to the village cadastre maps would be helpful to sampling office staff especially for check area.

4.3 Training Programs

Sampling staff has not got adequate training program for how to use the traditional equipments such as the tape or other related equipments for measuring area under crops, and they need more training in drawing sketches and analyzing data. During the summer crops area study, which was conducted by MVE/APRP in five governorates in year 2001, it has been found that sampling staff have received some training but not sufficient for using the traditional equipments for area measurements.

4.4 Data Collection

Data collection process, which is conducted within the three weeks (23 March – 11 April 2002). Table (2) demonstrates the timetable of data collection and staff training within the studied locations. For this purpose instruction in Arabic were prepared and distributed for all involved staff. Four staff members well trained on using new instruments within each governorate in addition to another four persons being chosen from each district for tape measurements and other data collected by questionnaires for winter crops area survey (extension agents inquiry data and farmers information).

4.5 Forms Applied in the Data Collection

New forms were developed for data collection, in two groups (see appendix A):
<u>Group I (Area checking)</u>

- Form A1 area: For selected cluster map, demonstrates the physical features of the cluster hodes and its boundaries, to facilitate finding the selected parcels.
- Form A2 area: For selected parcels sketch of different winter crops: Wheat, Berseem, Fava bean and onion.
- Form A3 area: For the comparisons between the four methods of area measures: instrument, tape, extension, and farmer.

<u>Group # 2 (Forecasting of summer crops)</u>

- Form C1 for sample farmers intention survey

- Form C2 for data on selected clusters level on summer crops 2001, winter crops 2002, and summer crops 2002, inductive, Expected (Planted and achieved).

- Form C3, C4, C5 the same data as form C2 but for the village, district, and Governorate levels; respectively.

4.6 Data Processing

The first step in data processing is to conduct a careful check and review of all forms right after they are received in the office from the field. Reviewing and editing field reports is very important to maintain consistency. However, over editing can introduce bias into the survey results. Data reviewers need to keep several factors in mind when reviewing field data: (a) the main purpose of editing should always be to get a high quality data, (b) field enumerators work under difficult conditions and sometimes may record errors, (c) the review process should be done in the governorate offices to take advantage of the staff knowledge about local conditions. Reviewers must work closely with field enumerators.

When the data were computerized, the data entry program was designed to do some of the editing process. Data summary are investigated and carefully reviewed. However, even though data validation was always emphasized, it happened that some averages or ratios appear to be outside the accepted domains of the studied random variable, which required further diagnoses for possible causes or errors. Data editing can also be continued when conducting statistical analysis via looking at various relationships of the collected data. Computer best does this procedure, but it can be done by hand calculations if necessary.

4.7 Annexes

Annex A includes forms of data collection, while Annex B contains Analysis of variance (ANOVA), and Annex C contains estimation of linear regression parameters.

Table 2: Timetable for Estimating Winter Crops Area by Check- Sample, 2002

Governorate	Districts	Period	No. Of trainees And surveyors		Total	Supervisors
			Instrument	Tape		
Minya	Menia & Mallawy	23/3 – 25/3	4	8	12	2
Assiut	Assiut & Dairout	26/3 – 28/3	4	8	12	2
Beheira	Damenhor & Delengat	1/4 – 2/4	4	8	12	2
Daqahleya	Belkas & Agga	3/4 – 4/4	4	8	12	2
Gharbeya	Tanta & Zefta	7/4 – 8/4	4	8	12	2
Sharqeya	Zagazig & Diarb negm	9/4 – 11/4	4	8	12	2
Total		**3 weeks**	**24**	**48**	**72**	**12**

5. STATISTICAL ANALYSES OF THE SURVEY DATA

5.1 Check Sample on Winter Crop Area

The assessment of existing methods mentioned earlier can be largely released by conducting a check-sample of area in conjunction with crop-cutting surveys in the nation-wide sample surveys on wheat conducted in 2002. That is, the same clusters selected and the same fields within selected clusters (four fields) for wheat crop forecasting work, in addition to select fields for berseem, fava beans and onions as mentioned before.

The detailed statistical results of this check-sample for the major winter crops in the selected six governorates are discussed on the appendices. The following section includes a summary of the main results.

5.2 Comparison of the Four Methods Using Index Numbers

A comparison of the four methods: (a) Measurements by a new optical instrument. (b) Measurement by a tape, drawing a sketch and calculation of area by triangulation, (c) Extension inquiry, (d) Farmer inquiry, has shown that the bias due to error in sketching and measurement by the tape is relatively small at both sample and governorate level, thus the index number in Table 3 using instruments as a control was about 102% for wheat, 104% for both berseem and Fava beans, and 100% for onion. The bias due to inquiry extension or farmer was large in terms of index numbers; it was about 105% for wheat, 119%, for berseem 104% and 103% for fava beans, and 108% and 103% for onions. Table 4 shows levels.

Table 3: Comparison of Methods on the Total Sample Level Using Index Number

Crop	Wheat				Berseem			
	Instr.	Tape	Exten.	Farm.	Instr.	Tape	Exten.	Farm.
Average	27.056	27.53	28.427	28.354	14.173	14.781	16.929	16.429
Index number	100	101.752	105.067	104.717	100	104.29	119.45	115.92
Crop	**Fava Beans**				**Onions**			
	Instr.	**Tape**	**Exten.**	**Farm.**	**Instr.**	**Tape**	**Exten.**	**Farm.**
Average	16.924	17.603	17.45	17.70	40.246	40.666	43.666	41.333
Index number	100	104.01	103.11	104.58	100	100.11	108.5	102.70

Source: Calculated from the MVE/APRP Sample Survey, April 2002.

Table 4: Comparison of Methods Selected Governorates, Using Index Numbers

Gov.	Wheat				Berseem			
	Instr.	Tape	Exten.	Farm.	Instr.	Tape	Exten.	Farm.
Beheira	100	102.19	114.9	108.57	100	100.5	120.36	117.44
Gharbia	100	105.41	113.1	115.54	100	103.7	113.55	103.68
Dakahlia	100	99.407	98.44	97.50	100	103.07	100.50	108.16
Sharkia	100	102.42	95.87	97.64	100	103.93	97.76	102.35
Menia	100	98.76	103.61	103.61	100	110.58	144.32	144.32
Assiut	100	105.37	107.55	111.68	100	103.3	127.84	118.42
Total	**100**	**101.75**	**105.07**	**104.80**	**100**	**104.29**	**119.45**	**115.92**
Gov.	**Fava Beans**				**Onions**			
	Instr.	**Tape**	**Exten.**	**Far.**	**Instr.**	**Tape**	**Exten.**	**Far.**
Beheira	100	102.83	101.59	102.67	-	-	-	-
Gharbia	100	113.45	117.12	124.44	100	99.77	108.85	103.07
Dakahlia	100	103.50	100.56	104.37	100	102.20	106.34	100.53
Sharkia	100	102.96	105.88	99.65	-	-	-	-
Total	**100**	**104.01**	**103.11**	**105.18**	**100**	**100.11**	**108.50**	**102.70**

Source: Calculated from the MVE/APRP Sample Survey, April 2002.

5.3 Comparison of Sample Means Using Matched Pairs t-test

As it is already shown from the survey design and structure, the observations of the four methods could be paired. These pairs would be used in testing the hypotheses of the differences between the instrument method and each of the other three methods. The null hypothesis to be tested is that the difference between the two population means is being equal to zero; the alternative is that it does not zero.

Table 5 shows the t-test in pairs for the four crops, using 96 paired of observations for wheat crop where the tape difference are about 0.47 kerat per field and about 1.3 kerat per field for both extension and farmer, but all are not significant. For berseem (70 observations) difference means are 0.61, 2.75, 2.26 for the tape, extension, and farmer; respectively, and all are significant at the level 0.01.

The tape showed less difference between means, but it has also less standard error. On the other hand, the comparison of the results of check-sample with extension inquiry and farmers revealed large and many kinds of discrepancies when observed at field level. The fact is that in almost all inquires there are large and indeterminate bias of the enumerators and the only solution is to conduct a check-sample every year to correct them.

Table 5: Matched Pairs t-Test for Different Methods vs. Instrument Measurement Method in Che ck Sample of Winter Crop Area as in year 2002

Crop	Method	d.f	Ave. Difference (kerate)	Standard Error	T_c	Significance
Wheat	Tape	95	0.474	0.279	1.699	-
	Extension	95	1.371	0.726	1.888	-
	Farmer	95	1.298	0.715	1.815	-
Berseem	Tape	69	0.609	0.129	4.721	0.01
	Extension	69	2.757	0.70	3.938	0.01
	Farmer	69	2.257	.659	3.425	0.01
Fava Bean	Tape	19	0.679	0.216	3.143	0.01
	Extension	19	0.526	0.652	0.806	-
	Farmer	19	0.776	0.523	1.483	-
Onion	Tape	5	0.045	0.894	0.050	-
	Extension	5	3.420	1.206	2.836	0.05
	Farmer	5	1.087	1.59	0.684	-

Source: Calculated from the MVE/APRP Sample Survey, April 2002.

5.4 Size of Errors

As it is shown in table 3 that the magnitude of errors in average for different methods, for wheat extension and framers were over estimated by about 3%, 5%, while tape were over estimated by about 1.7% in average. For berseem the tape is over estimated the area by about 3%, while extension agents and farmers over estimated the area under the crop by 20%. For area estimate under fava bean, area is over estimated by about 4% for tape, 3% by extension and about 4.7% for farmers. For onion, the tape is close to instrument and the difference is only about 0.3%, but extension agents estimate of the area is over by about 8.7%, while farmers are over estimated by about 2.9%.

5.5 Accuracy Level of Methods Measurement

5.5.1 Root Mean Squared Error (RMSE)

The RMSE as a measure of size of errors between instrument measurements and other methods neglects the sign of error. From table 6 we could say that RMSE for tape is less than estimates of the other methods of extension agents and farmer. For wheat the RMSE was 2.76 while, it was about 7.0 for both extension and farmer. For berseem the RMSE was about 1.2 for tape, while it was about 6 for both extension agents and farmers. For fava beans, it was 1.16 for tape and about 3.17 for extension and 2.7 for farmer. For Onion, the RMSE was about 2.0 for tape and 4.3 for extension and 7.70 for farmer.

5.5.2 Average Absolute Percentage Error (AAPE)

The AAPE reflects the errors whether it is positive or negative. Table 6 demonstrates that the tape has the minimum errors from the instrument than the other methods. For wheat AAPE for tape was about 5.50% vs. 18.7%, 14.9% for extension and farmer estimates respectively.

For berseem AAPE was about 8.15% for tape and 37.4% for extension 19.7% for farmer measurements. For Fava bean AAPE was about 4.7% vs. 20.1% for extension and 11.4% for farmer. For Onion it was 8.80% for tape measurement vs. 23.4% for extension and 13.3% for farmer.

5.6 Direction of Errors

Table 7 demonstrates the distribution of ratios between the area measured by instrument and extension method for wheat crop in the 6 Governorates of the survey. It seems that most (about 63.5%) of the ratios lies under 100%. This means that extension data direction tends to over estimate the area under wheat crop. Table 8 for berseem shows the same direction in most governorates especially in Beheira and Gharbia and Menia on sample level about 80% of extens ion measurements over estimates the area under berseem crop. For fava beans, Table 9 shows slight trend to overestimate area under the crop.

Table 6: Accuracy Level for Different Methods and Crops, as in Check Sample, 2002

Total Sample level				
Crop	**Method**	**R.M.S.E**	**A.A.P.E**	
			Average (%)	**S.E**
Wheat	**Tape**	2.760	5.514	0.632
	Extension	7.206	18.761	2.097
	Farmer	7.091	14.917	1.366
Berseem	**Tape**	1.234	8.154	0.782
	Extension	6.437	37.398	8.896
	Farmer	5.924	19.636	2.324
Fava Beans	**Tape**	1.162	4.719	1.031
	Extension	3.170	20.128	5.657
	Farmer	2.736	11.429	1.932
Onion	**Tape**	2.00	8.799	5.481
	Extension	4.355	23.415	14.684
	Farmer	7.709	13.319	7.275

Source: Calculated from MVE/APRP Sample Survey, April 2002.

Table 7: Frequency Distributions of Ratios Between Instrument and Extension Measurements of Wheat Crop Area in Selected Governorates

Classes %	Beheira		Gharbia		Dakahlia		Sharkia		Menia		Assiut		Total		Comul.
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
< 40															
40 - 50			1	6.3									1	1.0	1.04
50 - 60									2	12.5	1	6.3	3	3.1	4.16
60-70	2	12.5							1	6.3	1	6.3	4	4.2	8.33
70-80	3	18.7	2	12.5			1	6.3	2	12.5			8	8.3	16.66
80-90	5	31.3	4	25.	3				3	18.8	3	18.8	18	18.8	35.41
90-100	3	18.8	5	31.3	6		5	31.3	3	18.8	5	31.3	27	28.1	63.53
100-110			1	6.3	3	18.8	4	25.0	1	6.3	4	25.	13	13.5	77.07
110-120	2	12.5	1	6.3	2	12.5	3	18.8	1	6.3	1	6.3	10	10.4	87.49
120-130			1	6.3	1	6.3	2	12.5	1	6.3			5	5.2	92.70
130-140	1	6.3							2		1	6.3	4	40.2	96.87
140-150					1	6.3							2	2.1	98.96
150 >			1	6.3			1	6.3					1	1.0	100
Total	16	100	16	100	16	100	16	100	16	100	16	100	96	100	

Source: Calculated from MVE/APRP Sample Survey, April 2002.

Table 8: Frequency Distributions of Ratios Between Instrument and Extension Measurements of Berseem Crop Areain Selected Governorates

Classes %	Beheira		Gharbia		Dakahlia		Sharkia		Menia		Assyout		Total		Comul.
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
< 40			1	10					3	18.75	1	6.25	4	5.71	5.71
40 - 50									1	6.25	1	6.25	3	4.29	10.0
50 - 60											2	12.5	2	2.86	12.86
60-70	1	10							1	6.25	2	12.5	4	5.71	18.57
70-80	2	20	2	20	3	30			1	6.25	1	6.25	9	12.86	31.43
80-90	2	20	2	20	2	20	1	10	6	37.5	2	12.5	15	21.43	52.86
90-100	4	40	4	40	3	30	4	40	4	25			19	21.43	80.0
100-110	1	10			1	10	1	10			3		6	27.14	88.57
110-120					1	10	2	20			1	18.75	4	8.57	94.28
120-130			1	10							2	12.5	3	4.29	95.57
130-140											1	6.25	1	1.43	100
140-150					1	6.25									
150 >															
Total	**10**	**100**	**10**	**100**	**10**	**100**	**8**	**100**	**16**	**100**	**16**	**100**	**70**	**100**	

Source: Calculated from MVE/APRP Sample Survey, April 2002.

Table 9: Frequency Distributions of Ratios Between Instrument and Extension Measurements of Fava Beans Crop Area in Selected Governorates

Classes %	Beheira		Gharbia		Dakahlia		Sharkia		Total		Comul.
	Freq.	%	Freq.	%	Freq.		%	Freq.	%	Freq.	
< 40											
40 - 50	1	16.67							1	5	5
50 - 60											
60-70							1	12.5	1	5	10
70-80							1	12.5	1	5	15
80-90			1	50	1	25	1	12.5	3	15	30
90-100	2	33.33	1	50			2	25	5	25	55
100-110	1	16.67			2	50			3	15	70
110-120	2	33.33			1	25	1	12.5	4	20	90
120-130							2	25	2	10	100
130-140											
140-150											
150 >											
Total	6	100	2	100	4		100	8	100	20	100

Source: Calculated from MVE/APRP Sample Survey, April 2002.

$$Ratio = \frac{\text{Field instrument area}}{\text{Field extension area}}$$

5.7 Winter Crops Area Estimation

Table 10 demonstrates wheat area for the check sample survey 2002, applying ratios and linear regression equations for selected governorates and total sample, which is used to estimate the area under wheat crop for using field level ratios, sample level ratios and regression estimates for these governorates and their total Table 11. The data of Table 12 shows the area of check sample on total sample level for wheat, berseem and onion crops; ratios and linear regression equations. Table 13 demonstrates the area under wheat, berseem, fava beans and onion estimates using these estimators. A comparison of the four methods' estimates (instruments, tape, extension and farmer) shows that the later two are less efficient than the formers (see Tables 10, 11, 12& 13).

Table 10: Wheat Area Applying Check Sample, 2002 Ratios and Linear Regression Equations

Gov.	Ratio Estimated				Equation	Dependent Mean (Kerat)	S.E %
	Field Level Ratios		Sample Level Ratios				
	R_1	S.E (%)	R_2	S.E (%)			
Beheira	0.891	5.16	0.870		$\hat{y}$ = 2.4468+0.7924 x (1.076) (12.612)	27.61	3.96
Gharbia	0.971	7.21	0.887		$\hat{y}$ = 4.1331+0.6826 x (1.872) (7.346)	17.913	6.50
Dakahlia	1.085	7.28	1.031		$\hat{y}$ = 4.2566+0.9477 x (1.012) (16.907)	52.887	5.80
Sharkia	1.065	3.76	1.043		$\hat{y}$ = 1.9523+0.8154 x (1.644) (7.811)	10.625	3.96
Menia	0.918	7.30	0.965		$\hat{y}$ = -7.4247+1.2893 x (1.076) (12.612)	22.976	7.67
Assyout	0.945	5.08	0.929		$\hat{y}$ = 0.3969+0.9176 x (1.076) (23.04)	30.276	3.40
Total sample	0.968	2.07	0.952	2.73	$\hat{y}$ = -0.1969+0.9587 x (-0.2) (39.74)	27.06	2.65

Source: Calculated from MVE/APRP Sample Survey, April 2002.

$R_1 = \sum_{i=1}^{n} \frac{R_i}{n}$

$R_i = y_i / x_I$ (Field level)

Where
Y_i = Instrument field area number i
X_i = Extension field area number i

$R_2 = \frac{\overline{Y}}{\overline{X}}$ (Sample level)

Where
Y= Average of fields area under the crop measured by instrument in the sample
X = Average of fields area under the crop measured by extension in the sample

Table 11: Estimates of Gross Wheat Area Applying Quality Check Sample

(Feddans)

Gov.	Extension Area	Area Estimates Based on Ratio (R)				Area Estimates Based on Reg. Equation		Malr Final Area
		Field level (R)	S.E %	Sample level (R)	S.E %	Sample level (R)	S.E %	
Beheira	227549	202746	5.16	198036		200475	3.96	213252
Gharbia	121376	117855	7.21	107683		110853	6.50	121376
Dakahlia	221040	239828	7.28	227826		227269	5.80	219040
Sharkia	259175	276021	3.76	270345		258941	3.96	259175
Menia	177177	162648	7.30	171011		171170	7.67	163430
Assyout	142732	134881	5.08	132698		132842	3.40	133991
Sum	1149049	113979	-	1107598		1101552	-	1110264
Total (sample level)	1149049	1112509	2.07	1093665	2.73	1093232	2.65	1110264

Source: Calculated from table (9) , survey data and MALR area estimates.

Table 12: Area of Major Winter Crops Applying Check Sample, 2002, Ratios and linear Regression Equations

Crop	Ratio estimated: Field level ratios		Ratio estimated: Sample level ratios		Regression Equation	Dependent mean (Kerat)	S.E %
	R_1	S.E (%)	R_2	S.E (%)			
Wheat	0.96	2.07	0.9518	2.73	y = -0.1969+0.9587 x (-0.2) (39.7)	27.06	2.65
Berseem	0.87	3.57	0.8372	4.96	y = 0.6513+0.7987 x (0.55) (13.66)	14.17	4.59
Fava Bean	0.97	5.15	0.9696	2.68	y = -0.0954+0.9753 x (-0.01) (24.81)	16.92	3.92
Onion	0.85	8.23	0.9217	4.71	y = -1.7227+0.9611 x (-1.26) (45.06)	40.25	2.48

Source: Calculated from survey data

Table 13: Gross Area of Major Winter Crops Applying Check Sample, 2002, Total Sample

(Feddans)

Crop	Extension area	Area estimates based on ratio (R)				Area estimates based on reg. equation	
		Field level (R)	S.E %	Sample level (R)	S.E %	Sample level	S.E %
Wheat	1149049	1112509	2.07	1093665	2.73	1093232	2.65
Berseem	932513	811286	3.57	780700	4.96	787660	4.59
Fava Bean	228513	221658	5.15	221566	2.68	221580	3.92
Onion	29908	25422	8.23	27566	4.71	27465	2.48

Source: Calculated from data base of the survey

5.8 A Comparison of Estimates

Field level ratio estimate, total sample level ratio estimates and regression estimates, show that the latter two are more closer than the former in terms of easy of computation, however, the ratio estimate is recommended in routine work

A comparison of the sample estimates for gross area for wheat, Berseem, Fava bean and onion shows that the two are almost the same. It will be seen that the standard errors of the ratio estimates and regression are considerably the same (2-3% S.E sample level). This was to be expected in the sense of the high correlation between field areas of different methods. The results demonstrate the sample of 96 check-sample, while, between the governorates a precession of 3-5% would be attained. Thus we have to calculate the optimum sample size.

The problem of bias in the ratio estimates of areas for estimating the governorates production .However, area figures based on combined ratio estimates should be used in view of its smaller bias.

An investigation to determine the optimum sample size for estimating the area under wheat crop and other principal crops would be undertaken in other paragraphs.

5.9 Optimum Sample Size

The results of the pilot survey provide guidance for the planning of future surveys. The pooled analysis of variance of ratios on field level (instrument/extension), can be utilized for determining the number of clusters (the primary sampling units), which have to be sampled, the selected number of fields (or the secondary units) per cluster in order to estimate the total area under the crop with a given accuracy. This can be done with the help of the following equation.

$$\mathbf{v}\left(\mathbf{Y}_{\mathbf{nm}}\right) = \frac{\mathbf{C}}{\mathbf{n}} + \frac{\mathbf{F}}{\mathbf{nm}}$$

Where: $\mathbf{v}\left(\mathbf{Y}_{\mathbf{nm}}\right)$ is the variance of the average ratio

n: is the total number of clusters selected.

m: is the number of fields selected in each cluster, C and F are the true variances estimated "between clusters" and "between fields" respectively; and n is distributed among the difference strata proportional to the area under the crop. The results of the application of this equation to the wheat data are given in table (13) and of berseem in table (15). It can be seen that by sampling about 20 clusters with four fields per cluster, it would be possible to estimate the governorate crop area with a sampling error approaching 3 %. On the other hand, if a higher precision is needed, e.g. 2% level is targeted; it would be desirable to sample more than 40 clusters with 4 fields per cluster. Tables 15, 17 and 19 explains sample size when using instrument sample only to estimate area under wheat, Breseem, Fava bean without using ratio estimate as mean per unit. This implies a larger number of clusters.

Table 14: Number of Clusters Required for Estimating the Area Under Wheat with Different Percentage Standard Error and Different Number of Fields Selected per Cluster Using Check-Sample and Ratio Estimates

No. of Fields Per Cluster	Percentage Standard Error							
	1	2	3	4	5	6	7	8
	Number of Clusters							
1	527	132	59	39	22	15	11	9
2	287	72	32	18	12	8	6	5
3	207	52	23	13	9	6	5	4
4	167	42	19	11	7	5	4	3
5	143	36	16	9	6	4	3	3
6	127	32	15	8	5	4	3	2
7	116	29	13	8	5	4	3	2
8	107	27	12	7	5	3	3	2

Source: Calculated from Nested Analysis of Variance of Ratios between instrument measurement and extension data on sample field level of wheat crop.

Table 15: Number of Clusters Required for Estimating the Area Under Wheat with Different Percentage Standard Error and Different Number of Fields Selected per Clusters Using Instrument Estimates Only

No. of fields Per Cluster	Percentage Standard Error							
	1	2	3	4	5	6	7	8
	Number Of Clusters							
1	11500	2875	1278	719	460	319	235	180
2	6774	1693	753	423	271	188	138	106
3	5198	1300	578	325	208	144	106	81
4	4411	1103	490	276	176	123	90	69
5	3938	984	438	246	158	109	80	62
6	3623	906	403	226	145	101	74	57
7	3398	849	378	212	136	94	69	53
8	3229	807	359	202	129	90	66	50

Source: Based on Nested ANOVA of sample instrument measurements of Wheat

Table 16:Number of Cluster Required for Estimating the Area Under Berseem with Different Percentage Standard Error and Different Number of Fields Selected per Clusters Using Ratio Estimates

No. of Fields Per Cluster	Percentage Standard Error							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Number Of Clusters							
1	747	187	83	47	30	21	16	12
2	456	114	51	29	19	13	10	8
3	359	90	40	23	15	10	8	6
4	311	78	35	20	13	9	7	5
5	282	70	32	18	12	8	6	5
6	262	66	30	17	11	8	6	4
7	249	62	28	16	10	7	5	4
8	238	60	27	15	10	7	5	4

Source: Calculated from Nested Analysis of Variance of Ratios between instrument measurement and extension data on sample field level of Berseem crop.

Table 17: Number of Cluster Required for Estimating the Area Under Berseem with Different Percentage Standard Error and Different Number f Fields Selected per Clusters Using Instrument Estimates

No. of fields Per Cluster	Percentage Standard Error							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Number of Clusters							
1	3935	988	439	247	158	110	81	62
2	2428	607	270	152	97	67	50	38
3	1919	480	213	120	77	54	40	30
4	1665	416	185	104	67	47	34	26
5	1512	378	168	95	60	42	31	24
6	1411	353	157	88	56	40	29	22
7	1338	335	149	84	54	38	28	21
8	1284	321	143	80	52	36	27	20

Source: Based on Nested ANOVA of sample instrument measurements of Berseem

Table 18:Numbe r of Cluster Required for Estimating the Area Under Fava Bean with Different Percentage Standard Error and Different Number of Fields Selected per Clusters Using Ratio Estimates

No. of fields per cluster	Percentage standard error							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Number of clusters							
1	539	138	60	34	22	15	11	9
2	269	68	30	17	11	8	6	5
3	180	45	20	12	8	5	4	3
4	135	34	15	9	6	4	3	3
5	108	27	12	7	5	3	3	2
6	90	23	10	6	4	3	2	2
7	77	20	9	5	3	3	2	2
8	68	17	8	5	3	2	2	2

Source: Calculated from Nested Analysis of Variance of Ratios between instrument measurement and extension data on sample field level of Berseem crop.

Table 18: Number of Cluster Required for Estimating the Area Under Fava Bean with Different Percentage Standard Error and Different Number of Fields Selected per Clusters Using Instrument Estimates

No. of Fields Per Clusters	Percentage Standard Error							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Number Of Clusters							
1	7834	1958	870	490	314	218	160	123
2	3917	979	435	245	157	109	80	62
3	2611	653	290	163	105	73	54	41
4	1958	490	218	122	79	55	40	31
5	1567	392	174	98	63	44	32	25
6	1306	326	145	82	53	37	27	21
7	1119	280	124	70	45	31	23	18
8	979	245	109	62	40	28	20	16

Source: Based on Nested ANOVA of sample instrument measurements of Fava Beans

6. MAIN FINDINGS

The main findings of this study are:

- The sampling staff should be reminded of applying the main objectives of these new methods at the beginning of each season.

- Sampling staff should set up the implementation work plan in detail before beginning the fieldwork.

- There is need for a basic training classes and field demonstrations for using the new instruments and procedures of crop area measurements is in top priority of the survey.

- Explaining the new forms for data collection is essential before starting the fieldw ork.

- There is a need for supervisors at different levels to help in improving the data quality.

- A cluster map (Form A1), with its physical features and boundaries, facilitates finding the correct sample fields.

- It is highly important to develop better c ooperation between the extension staff in the village and cluster hodes and the sampling staff.

- There is a need to update the sampling frame(or the completeness of cluster survey).

- Most survey errors come from sources such as: uncompleted clusters, wrong farmers name, another field, and errors in parcels area.

- The sampling staff need to learn that the use of a check sample of area under the crop minimizes cost and efforts. But they do not have to divide the parcels and fields, as they do in yield forecasting but measure it as a whole and compare the area with extension agents' estimation and farmer information.

- Before making a sketch of the selected parcels the sampling staff need to be sure that the selected fields are parcel in the sample.

- The existing errors can be summarized as follows:

  - Drawing the wrong field, or drawing a part of the field and other areas with it.

  - Not following the steps of drawing the field sketch: first, determine the direction of the field and start from the southwest corner, measure all the field directions and angles in meters and centimeters, measure the width of inside and outside channels, bonds, and other utilities or other crops inside. In the case of unusual fields, make it into triangles and rectangles, measure its dimensions and angles. The sampling staff need more training for making sketches.

  - Errors of measurement: measuring the wrong field, measuring part of the field, and reading the side of the inches of centimeter side. Not applying the right use of measurement tapes: use new ones, make it straight, while measuring, read it carefully, record numbers directly, check the measurements of dimensions

- The use of metallic tape is better than plastic tape, the use of a compass for measuring angles in conjunction with the use of tapes can raise the efficiency of crop area measurements.

- *Lessons learned from the summer crop area forecasting:* Farmers' planting intentions surveys gave good indicators for future farmers' crop areas and could be used to forecast main crops' area. Estimation of summer crop areas at the unit level (village) was found to be better than at any other level (cluster level, district level, and governorate level). This finding can be used in correcting the estimation of the future cropping.

- The sample size is determined on some subjective basis, but there was no attempts for applying the statistical formula of calculating the optimum sample size for different levels of standard error.

7. FORECASTING OF SUMMER CROP AREA IN 2002

In the survey conducted in April 2002 to forecast summer crops area from the present available data related to principal winter crops area, various questionnaires were designed to:(1) collect data from a sampled farmers who cultivate major winter crops (wheat, berseem, fava beans, and onion), (2) collect data at the selected group level (eight groups per governorate with a total of six governorates); and (3) collect data at the study direction level (eight directions per governorate). In addition, data were collected at the district level (two districts for each governorate). Data related to crop composition in each of the studied governrates were also collected. All of those questionnaires are explained in the appendix and presented briefly.

- Carrying out a survey to study the sampled farmers' intentions (32 farmers/ governorate with four farmers/selected group). This includes an identification of the most important variables and its internal correlation's.

- Expected and actual areas for both summer and winter crop composition.

- Official expectations of next summer crop areas.
  In order to predict the principal crops area (cotton, paddy, and maize), percentage and linear regression were used. The process findings can be summarized as follows:

7.1 Farmers' Planting Intentions Survey

The findings of the planting intentions survey were encouraging (Form c). Table 20 shows the Ratio coefficient (R) between farmer's intentions for the next summer crop season of 2002, with that cultivated in the last summer season of 2001 (at the governorate level and the sample level). The R coefficients were about 0.84 for Cotton, 1.30 for Paddy, and 0.86 for Maize. Consequently, it was possible to expect areas of those crops in the next season Table 21. It is expected that the area to be cultivated in the six governorates next summer will be about 426,091, 1,069,061, and 1,091,706 feddans for cotton, paddy, and maize; respectively.

Tables in Annex E showed regression correlation's between principal summer crops in the years 2001 and 2002; principal summer crops in the year 2002 and winter crops in the year 2001; principal summer in the year 2001and winter crops in the year 2001. The tables indicate that determination coefficient varied between governorates

Table 20: Ratio Estimate of Intended and Actual Area of Major Summer Crops

Gov.	N	Cotton (Total area)			Paddy (Total area)			Maize (Total area)		
		Actual 2001 F	Intended 2002 F	R= Intent /Actual	Actual 2001 F	Intended 2002 F	R= Intent /Actual	Actual 2001 F	Intended 2002 F	R= Intent /Actual
Beheira	32	52.25	61.455	117.62	52.332	49.0	93.63	28.708	77.084	94.43
Gharbia	32	63.41	26.541	41.85	31.039	65.454	210.88	23.205	23.663	101.97
Dakahlia	32	39.957	40.0	100.1	119.166	150.416	126.22	39.624	39.124	98.74
Sharkia	32	8.371	2.208	26.38	19.664	25.204	128.17	11.541	11.956	103.59
Menia	32	5.583	9.0	161.20	-	-	-	84.866	77.536	91.36
Assiut	32	10.0	12.00	120.00	-	-	-	114.04	80.908	70.95
Sample	192	179.572	151.204	84.2	222.201	290.074	130.55	301.984	260.271	86.19

Source: Based on C1 forms of the survey.

Table 21: Expected Area of Major Summer Crops in year 2002

Gov.	Cotton			Paddy			Maize		
	Actual 2001	Ratio	Forecast 2002	Actual 2001	Ratio	Forecast 2002	Actual 2001	Ratio	Forecast 2002
Beheira	160048	117.62	188248	187578	93.63	175629	156957	94.34	148073
Gharbia	57457	41.85	24046	122322	210.88	257953	111317	101.97	113509
Dakahlia	92569	100.1	92662	281630	126.22	355473	232456	98.74	229527
Sharkia	75267	26.38	19855	218465	128.17	280006	258881	103.59	268175
Menia	38822	161.20	62581	-	-	-	296624	91.36	271004
Assyout	32249	120.0	38699	-	-	-	86566	70.95	61418
Total	456412	93.35	426091	809995	131.98	1069061	1142801	95.53	1091706

Source: Table (19) and forms C5 of the survey

7.2 Expected Areas (Questionnaires C2 to C5)

Correlation matrix related to summer and winter crops areas in the years 2001 and 2002 is established. The matrix data showed some significant correlation's, especially for C3 questionnaires, which reflected estimates of crops area at the unit level (Villages selected in the study). The findings showed significant correlation coefficients between:

- Maize area of the year 2002 and Maize area in the year 2001, Berseem areas (temporary and permanent), and wheat in the year 2001;
- Paddy area in the year 2002 and the areas selected to objective areas of Paddy , Cotton, Berseem (temporary and permanent), and actual wheat area of the year 2001;
- Cotton area of the year 2002 and objective areas related to each of Paddy and cotton in the year 2001, Berseem (temporary and permanent), and wheat and actual areas of Berseem (temporary and permanent), and wheat;
- Maize area of the year 2001 and target areas of wheat, permanent Berseem areas, and actual wheat area in the year 2001.
- Paddy area of the year 2001, and areas target each of cotton, permanent and the temporary Berseem of the year 2001, and actual areas of temporary and permanent Berseem.

- Target areas of cotton in the year 2001, target areas of Berseem (temporary and permanent),and actual areas of Berseem (temporary and permanent),.

- Target areas of temporary Berseem in the year 2001 (temporary) and actual areas of Berseem (permanent) of the year 2001.

- Target areas of permanent Berseem in the year 2001, target wheat area, and actual area of temporary Berseem.

- Target wheat areas in the year 2001, permanent Berseem, and actual wheat area of the year 2001.

- Temporary Berseem area of the year 2001, and permanent Berseem area of the year 2001,and

- Permanent Berseem area of the year 2001 and wheat area of the year 2001.

In addition, a survey to identify available relationship between actual and expected crop was conducted throughout the questionnaires C2 to C3, selected pond group, villages, districts, and governorates. The findings showed that the relationship were significant at high level regarding C3 data at the level of sample direction level. Table 20 showed that the Determination coefficient ranged between a minimum of 0.84 and a maximum of 0.96. This reflected the possibility of using regression in predicting summer crop areas.

7.3 Relationship between Winter Crops In 2001 and Summer Crops in 2002

This relationship was obtained by using regression, Table 20. Table 21 showed statistical analysis at the direction level with high determination coefficient which indicated the possibility of using this method in studying relationships between past winter crops and next summer crops.

7.4 Results

The results of the winter crops area estimation in the six govrnorates of the 2002 survey by the three methods are compared with the extension inquiry and are summarized in the following table. Table 22 shows that both of the ratio and regression estimates have given smaller sampling error; therefore, it is recommended to use the combined ratio. The comparison of Extension (subjective) estimates with the sample estimates of gross area shows that the inquiry figure is over estimating by about 5% for Wheat crop, 19% for Berseem, 3% for fava bean and about 8.5% for Onion.

Table 22: Comparison of Estimation Methods of Winter Crops Area 2002, Total Sample Level

Crop	Item	Extension inquiry	Check - Sample		
			Simple Ratio	Combined Ratio	Regression
Wheat	Area (feddans)	1149049	1112509	1093665	1093232
	Standard Error	-	23029	29857	28970
	Standard Error %	-	2.07	2.73	2.65
Berseem	Area (feddans)	932513	811286	780700	787600
	Standard Error	-	28963	38723	36151
	Standard Error %	-	3.57	4.96	4.59
Fava Beans	Area (feddans)	228513	221658	221566	221580
	Standard Error	-	11415	5938	8686
	Standard Error %	-	5.15	2.68	3.92
Onion	Area (feddans)	29908	25422	27566	27465
	Standard Error	-	2092	1298	681
	Standard Error %	-	8.23	4.71	2.48

8. RECOMMENDATIONS

8.1 General Recommendations

- It is useful to carry out an annual check-sample survey to improve the quality of the area estimates obtained by subjective complete enumeration, especially for the main crops. There were large differences between the sample measured by new instruments and the corresponding areas obtained by local agricultural extension staff inquiry at both the field and total levels. Adopting a check sample is likely to improve the quality of the subjective inquiry method.

- An investigation to determine the optimum sample size for estimating the area under the main winter crops especially wheat, berseem, and fava beans was undertaken based on analysis of variance using ratio estimates. It is recommended to increase the sample size gradually. It is better to select about 20 clusters per governorate randomly, and 4 fields for every crop randomly to obtain area estimates with about 3% standard error at the governorate level. This implies using 3 districts per governorate.

- In extending the area work to other governorates, it is better to add gradually every year 2 new governorates. This would require more equipment, and more training for the staff.

- MALR should restructure the sampling department and establish an area estimation unit to maintain the continuity of conducting the check sample survey.

- Improve the survey management and have a better organization for the fieldwork to increase the data quality, and reduce time, effort, and budget.

8.2 Specific Recommendations

8.2.1 Cluster Survey

- Check area work must be started after the last survey of the agricultural extension agent.

- Assign the responsibility of conducting a survey for main crops parcel-by-parcel, name-by-name to the extension agents.

- The use of cadastre maps could help check out the survey.

- Comparing the first check of the crop area done by the extension staff with the spot inspection by the sampling staff.

8.2.2 Sample Selection

- It is recommended to make the secondary sampling units (parcels) of equal size, say 3 feddans in average, by combining adjacent fields. This would raise the efficiency of sample representation and decrease the variance of the estimates.

- Do not partition the big crop parcels selected but it should be measure them as a whole.

- Use the same sample as for wheat forecasting to minimize efforts and cost. Select the fields of other crops.

8.2.3 Equipment Supply

To extend check sampling of area to new governor ates in the survey requires the purchase of more equipment especially optical instruments, compass and metallic tapes. It is recommended to buy three sets every year.

8.2.4 Training

- Develop more training courses for sampling staff to use the new instruments for crop area measurements.
- Provide training on applying appropriate sampling techniques
- Increase the skills in the useof tape and compass
- Use metallic tapes to measure field dimensions.
- Record the dimensions in meters and centimeters directly on a sketch.
- Make a sketch with the appropriate scale to reflect the physical features of the field and calculate the crop area.
- Measure the inside and outside of field utilities.

8.2.5 Research

- Research for developing new methodologies measuring area under main crops is of top priority.
- Investigate how to best combine the results of the new and old methods during the transition period.
- Study the possibility of using satellite images for crop area estimation.

8.2.6 Farmers' Planting Intentions Survey

This should be a regular survey conducted twice a year (in winter and summer seasons). It will be of great benefit for crop area forecasting. Policy makers could use the farmers planting intentions survey for making better agricultural policy.

REFERENCES

Fawzy, M, A et al: **Availability and Quality of Agriculture Data in Egypt**, APRP, MALR, Egypt 1998, Report No:4

Fawzy, M, A et al: **Short-term Wheat Yield Forecasting in Egypt**: An Assessment, MVE unit, APRP, MALR, Egypt, April, 2001, Report No:16

FAO Publication : **Estimation of Crop Areas and Yields in Agricultural Statistics**, Rome 1982.

FAO Publication : **Estimation of Areas in Agricultural Statistics** , Rome 1965.

FAO Publication : **Multiple Frames Agricultural Survey**, Vol.1, Rome 1996.

Ghazi, M.R. : **Estimation of Area under Principal Crops and Optimum Size of Cluster Sample** , Ministry of Agriculture, Egypt, 1962.

Koshal, R.S. : **Development of Sample Surveys for the Estimation of Agricultural Production**, Ministry of Agriculture, 1962.

Mubarak, R.M. : **A Study of Statistical Estimation Methods of Egyptian Crops. M.S.C. Thesis**, Ain-Shams University, 1977.

Mubarak, R.M. : **Improvement of Statistical Agricultural Production Estimation Methods in Egypt**, PHD. Thesis Ain-Shams University, 1998.

Mubarak, R.M. : **Improvement of Main Agricultural Crops Statistics Areas in Egypt**, Agricultural Economics Research Institute, MALR, 2002.

USDA, NASS, : **Basic Agricultural Survey Statistics and Methods** , A Training Course, USDA, 1987.

Zarkovich, S.S. : **Quality of Statistical Data**, FAO, Rome, 1975.

MALR, EAS, : **Agricultural Statistics Records** .

ANNEXES

ANNEX (A)

ANNEX (B)

ANNEX (C)

TABLE OF CONTENTS

LIST OF ACRONYMS

ANOVA	Analysis of Variance
APRP	Agricultural Policy Reform Program
ARC	Agricultural Research Center
AERI	Agricultural Economic Research Institute
ATUT	Agricultural Technology Utilization and Transfer (USAID funded project)
CAAE	Central Administration for Agricultural Economics
CAPI	Central Administration for Planning and Information
DF or df	Degrees of Freedom
EAS	Economic Affairs Sector
ESA	Egyptian Survey Authority
FAO	Food and Agriculture Organization (UN)
GARPAD	General Administration for Reclamation, Projects, and Agricultural Development
GIS	Geographic Information System
GOE	Government of Egypt
GTZ	Deutsche Gesellschaft fuer Technische Zusammenarbeit
IFPRI	International Food Policy Research Institute
MALR	Ministry of Agriculture and Land Reclamation
MOA	Ministry of Agriculture
MIWR	Ministry of Irrigation and Water Resources
MS	Mean Square
MHTS	Ministry of Home Trade and Supply
MVE	Monitoring, Verification and Evaluation Unit
PBDAC	Principle Bank for development and Agricultural Credit
PSU	Primary Sampling Unit
RDI	Reform Design and Implementation (APRP Unit)
SS	Sum of Squares
UAES	Undersecretary of Agricultural Economics and Statistics
US	United States
USAID	United States Agency for International Development
USDA	US Department of Agriculture

EXECUTIVE SUMMARY

To estimate or forecast the volume of production of the major field crops good data are needed for both yield and crop area. The MVE unit had conducted some activities regarding yield, but APRP had not made any effort to improve the estimation of area. It is essential to have good area data because these data are used to document the growth rate of production and to study the impact of agricultural policy on these crops. This is important both for impact assessment in general and for policy makers in Egypt in particular.

The method used by the Egyptian Survey Authority (ESA) to obtain crop area by complete enumeration and measurement on the ground was very expensive. Hence it was necessary to develop a sampling technique of partial enumeration to reduce costs and effort. The area under wheat since 1957 and the area under cotton since 1958 have been estimated on the basis of a sample involving measurement of area by a kassaba in 50% of the cultivated land in Egypt. But since1990, there have been many problems in the use of this objective method such as: 1) the last base year (1961) became out of date. 2) the budget, which was about LE 3-4 million/year. 3) The cadaster maps are too old. Therefore, to obtain crop area estimates, ratios were used to adjust the estimates of inquiry in the sample measured by the ESA. However, the agricultural year 1999/2000 was the last year in which the ESA area measurements were used. MALR decided to stop using this method, and tried to find a more accurate and less expensive technique to. The proposed in this study technique is based on a check-sample of the area determined by subjective methods of the agricultural local staff to remove its bias. The subjective methods based on inquiry by agricultural extension staff have become the only method for crop area estimation. Therefore the check-sample is one potential method to use in order to remove the indeterminate bias of this subjective method. Another way to improve the quality of crop area estimates is to use new instruments. The team tested such instruments in the selected governorates.

The main objectives of the area estimation activity were to:

- Assess the availability and quality of agricultural data for the area of major summer crops (cotton, rice and maize) and winter crops (wheat, berseem and fava beans)
- Propose an advanced objective methodology and sampling procedure to estimate the area of these crops.
- Estimate the main winter crops area using newly purchased, modern equipment and train the EAS staff in using it in the selected governorates.
- If possible, propose an advanced objective methodology and procedures to forecast the expected area of summer crops at the time of measuring the winter crops area.

The objectives mentioned were achieved by conducting a check-sample survey of area in conjunction with crop-cutting surveys. The MVE team adopted a work plan of two phases: phase one for summer crops and phase two for winter crops. During the first phase, the team (a) assessed the current procedure for crop area estimation, with special attention given to the major summer field crops, i.e. cotton, rice, and maize, (b) examined the procedure for obtaining the published statistics (of MALR), starting

from the village level, (c) developed an improved method to be adopted for estimating and measuring the crop area of these crops,(d) selected a representative sample of districts and villages and conducted a limited sample survey of key data elements in these sites to test the feasibility of data collection, and (e) conducted a statistical analysis to compare the data obtained from the survey with the data collected by MALR at the governorate. Level. The pilot study was conducted in the following governorates: Gharbia, Behira, Dakahlia, Minia and Assiut.

In the second phase, the techniques that were developed during the summer season and the new equipment that the EAS has purchased were applied during the winter season. The EAS staff were trained on using the new equipment in the same governorates in addition to Sharkia governorate.

An additional objective of the second phase was to develop a forecasting procedure for the area of the major summer crops using the data on area of winter crops and other information. This procedure was tested using the area data from the MALR indicative cropping pattern and also the actual area.

It is important to note here that the objectives of this work were not only measuring and plotting the area of each farmer's field, but also choosing the best method to measure crop area.

The area under each selected parcels was estimated by four methods: (a)direct measurements by the MVE team using a modern optical instrument, (b) direct measurement by sampling staff using a tape on the ground, (c) inquiry from the local extension staff in the village, (d) farmers' estimate for his crop area. These areas were compared with each other by applying statistical analysis. More information about forecasting summer crops was collected from farmers and local staff. The data were carefully checked and reviewed, and field areas were computed. All of the data were submitted to the EAS.

On the job training for some sampling staff was conducted regarding the use of the new instruments, and the others were trained in using tape and in survey data collection. An advanced training course was held for area measurement and calculation.

The check-sample technique using the new optical instrument proved that subjective methods based on inquiry by extension agents or farmers' data overestimate crop area and need to be adjusted, while using tape was relatively close to instrument measures. To adjust and correct the extension estimates or to remove bias, ratio estimates and regression estimates were successfully used to obtain area estimates with acceptable levels of sampling error at both the governorate and the total sample levels.

The study demonstrated the possibility of using a farmers' planting intention survey to forecast the expected area. Using data of the indicative and actual cropping pattern in the selected villages level gave good results in this domain.

Recommendations can be summarized as follows:

- The necessity for using check-sample to improve crop area estimation.
- Apply this method in more governorates
- Increase sample size depending on optimum sample size calculated
- Purchase more optical instruments, compasses and metallic tapes.
- More training for sampling staff
- Further research for crop area estimation improvement.

VOLUME I: SUMMER CROP AREA ESTIMATION

Morsy Ali Fawzy
Abdallah Zein El-Din
Mostafa Bedir
Bayoumi Abdel Meguid Bayoumi

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGMENTS

The authors would like to acknowledge the wise guidance and scientific advice of Dr. Saad Nassar. Appreciation is also extended to Eng. Mahmoud Nour for his strong support during the study implementation. Special thanks go to Dr. Mohamed Omran for the long discussions, feedback, and his participation in designing and implementing this study. The authors are greatly indebted to Dr. Gary Ender, Chief of Party of the MVE Unit for his guidance, participation and support in formulating and implementing this report.

Appreciation should be extended to Eng. Mohamad El Shahed, the head of theEconomic Affairs Sector. Without his cooperation and assistance, this study would never have been completed. Appreciation is also extended to Eng. Abd El Razik Hassan, the head of the Central Administration of Agricultural Economics and Eng. Saed El Agaty, the Head of the Sampling Department, for their full support and cooperation.

The authors also would like to acknowledge the hard work and dedication of the researchers who conducted the field investigations: Eng. Mohamed El Sayed Abed, Sayed Gad El Moula, Abdel Hameed Mokhtar, Noshy Abdel Rahmna and Abdel Aziz El Samahy.

Appreciation is also extended to Mr. Mohamed Ibrahim and Mr. Mohamed Taha from the Faculty of Agriculture, in Alexandria University for their hard work in applying the new instruments.

Special thanks go to Mrs. Yvonne Louis for her hard work in data entry, tabulation, and file manipulation.

Finally, any errors and omissions should be attributed to the authors and not to the APRP, USAID, or MALR.

EXECUTIVE SUMMARY-SUMMER CROPS

To estimate or forecast the volume of production of the major field crops, good data are needed for both yield and crop area. The MVE unit had conducted some activities regarding yield, but APRP had not made any effort to improve the estimation of area. It is essential to have good area data because these data are used to document the growth rate of production and to study the impact of agricultural policy on these crops. This is important both for impact assessment in general and for policy makers in Egypt in particular.

The main **objectives** of this activity were to:

- Assess the availability and quality of agric ultural data for the area of major summer crops (cotton, rice and maize).
- Propose an advanced objective methodology and procedures to estimate the area of these crops.

Methodology. To achieve the above objectives, the MVE team adopted the following work plan. The team:

- Assessed the current procedure for crop area estimation, with special attention to the major summer field crops, i.e. cotton, rice, and maize
- Examined the procedure for obtaining the published statistics (of MALR), starting from the village level
- Reviewed any extension agents' notebooks for the major summer field crops in the selected villages.
- Developed an improved method to be adopted for estimating and measuring the crop area of these crops.
- Selected a representative sample of districts and villages and conducted a limited sample survey of key data elements in these sites to test the feasibility of data collection
- Carried out on the job training for the sampling staff at the governorate level in applying the improved method of measuring crop area
- Conducted a statistical analysis to compare the data obtained from the team's surveys with the data collected by MALR at the governorate level
- Established a database for the crop area data collected by the study

The pilot study was conducted in the following governorates: Gharbia, Behira, Dakahlia, Minia and Assuit.

Assessment of the Techniques

Old Measurement Technique (Taping). The sampling staff used to estimate the area of each field based on the following steps:

- Measuring all field lengths using the tape (20-50m).
- Measuring one of the traverse angles.
- Drawing a clear sketch showing the measurements.

- Dividing the traverse into triangular pieces, and calculating the area of each triangle separately and summing up the triangles' area in order to estimate the area.

Assessment. Practically, the old technique is suitable for small areas only. Some specific problems are:

- Using the tape for measuring lengths longer than its length means measuring the line part by part without alignment.
- This method always gives higher lengths than the original lengths by 10-15%.
- Field staff were measuring lengths on vertical slopes instead of the correct horizontal lengths. Measuring one angle for each traverse is not enough to draw the traverse for most cases.
- The method for measuring the internal angles using the surveying triangle is not correct.
- This method never gives close traverses.
- In some cases when there are curved edges, they could not handle it with taping. They simply assume that it is straight line, which creates another source of error.

The principal sources of linear measurement error are: Tape not stretched straight, wind, incorrect alignment (horizontal and vertical), careless plumbing over point, erroneous length of tape, variation in temperature and incorrect tension. Some of the above errors are caused by carelessness or lack of training of the staff; others are caused by not accounting for those errors that are inherent in the tape.

New Measurement Technique (Optical Instruments). At the beginning of the activity, the team decided to use the theodolite for measuring lengths and angles for each traverse, and using the tangential method for measuring lengths. To simplify the work, the team used the one-location method. This means that one should put the instrument on one corner of the traverse and measure the lengths of the two edges and diagonal length. If the traverse has more/less than 4 edges, one can measure it by sending rays to each corner from the one-point location and measuring all lengths and angles. By using the same calculation method described before, one can estimate the traverse area. If the traverse has curved edges, additional work should be done by sending many rays along the curve length to draw it.

Assessment. The first trial was fairly good, except that the theodolite needed time to be adjusted, and the tangential method needed more calculations to give the lengths. Therefore, the team decided to use the surveying level with the fixed hair stadia method for measuring lengths and angles. The team also used the two-point location method and the magnetic compass to find the directions.

The stadia method provides lengths directly, and the two-points location method gives five lengths for each traverse without any plotting correction. This method also eliminates any personal error. Moreover, this method provides a chance to double check each line length by calculation as described before.

Main Findings

Taping Measurements. The team's observations on taping are as follows:

- Field staff was measuring the field area as a rectangular area, neglecting any changes in edge shape and only measuring length and width.
- In some cases, there was error in stating the field location correctly.
- In most cases, only one angle was measured.
- It is important to note that the method used for measuring angles is not correct. Based on various tests, it was found that nobody knows how to use the surveying level for the measurement of angles.

Optical Instrument Measurements. The team found that:

- The stadia method with the level is the most suitable method to measure the distances for crop area estimation.
- The level provides not only distances and internal angles of traverses, but also changes in the traverse sides (curved, broken line).
- One can use the level easily to re-plot a complete cluster or italics with all its details following the two crop area estimation studies, a recommended training program was conducted to cover all the needs of the sampling department staff.
- The new instrument purchased by the MALR provides highly accurate measurements, including an auto-focus facility that significantly reduces measuring time.

Statistical Analysis

Matched pair t-test analysis showed significant differences between new instrument measurements and taping measurements in all governorates. The 95% confidence intervals of the ratio estimates of new instrument for almost all crops were mostly shorter than that of the taping measurements method. Thus, the ratio estimates (correction factors) obtained from the new instruments are more efficient to be used in crop area estimation. The final results of the study showed the fitted equations of the weighted ratio regression for cotton, maize and rice, as well as the total crop area obtained from the agricultural department before and after adjustment. These show that in general there is an overestimation of crop area in the selected governorates.

Conclusion and Recommendations

It is concluded that:

- The taping process is not suitable for crop area estimation, and the method of measuring angles using the surveying triangle is not correct.
- The new instrument method was more accurate than all other measurement methods.
- It is recommended that it be used to derive correction factors for adjustment of the extension agents' crop area estimates.

1. INTRODUCTION

1.1 Background

Egypt has a long history of gathering statistical data, but the quality has been variable. The Data Quality report is recommended reading for those interested in detailed information. Prior to 1955, only subjective methods were used to estimate crop areas. Experience has shown that these estimation procedures are usually unreliable.

Estimation of the major crops production depends on the yield (productivity multiplied by the area). Several sampling techniques and researches were used in Egypt for the last 45 years. Theses techniques were applied by the Economic Affairs Sector (EAS) to obtain reliable estimates for both area and productivity for the major crops, applying the objective method and actual measurements to obtain reliable estimates, free from any personal bias.

Although the development and upgrading of yield estimation methods were continue succeeded but crop area estimation faced several problems, that leaded to stop the actual area measurements using a sample of size 50% of the total planted area. A list of fields used to be sent and physically measured by the Egyptian Survey Authority (ESA) to verify the data quality of the planted area collected by the extension agents and corrects it accordingly.

Unfortunately, EAS stopped measuring the planted area of the major crops at the end of 1999 year. Therefore the only available data sources for the crop area estimation is the Agricultural Department at the district and governorate levels, which is collected and published by EAS. These data are usually collected by the extension agents at the village and district levels and use to be called “a complete survey data”.

The request to do this work came from the EAS of the MALR, who has had an interest in improvement of agricultural statistics for some time.

1.2 Study Objectives

The main objectives of this activity are to:

- Assess the availability and quality of agricultural data for the planted area of major summer crops namely cotton, rice and maize.
- Propose an advanced objective methodology and sampling procedures to estimate the planted area of these crops in the selected governorates.

The work is a natural follow-on to the data quality study made in 1999. This type of work was recommended in that report. It will enable MALR to better monitor and evaluate agricultural production, and verify the effects of agricultural policy.

2. ASSESSMENT OF CROP AREA ESTIMATION METHODS IN EGYPT

2.1 Background

Before 1957, area crop survey of the major crops cotton, rice, wheat and sugarcane was used to be completely surveyed using cadastral maps with scale 1:2500. This complete survey used to be carried out by the Egyptian Survey Authority (ESA), where all sides of the planted field were measured. Planted areas were colored marked on the maps and used to Calculate the net-planted area, excluding the unplanted area from the maps using the planimeter. In spite of being expensive, the complete survey had several errors:

1. Some planted segments (fields) may not be marked on the map.
2. Some vegetable or other secondary crop planted area may be added to the studied planted area of the major crops.
3. The measured area of the major crops may include canals, drains, roads, …etc.
4. Field and planimeter measurement errors.

These errors could be avoided (Ghazi, 1962) using a check sample along with crop-cutting experiments of cotton and rice in 1965. In this sample the planted area was measured by tape and area was calculated by the triangles using the planimeter to get the net-planted area.

Mubarak (1996) indicated that, the cotton area estimation of the agricultural departments in 1993 and 1994 were biased upward amounted by 4% and downward in 1996. However; he added, for rice crop area, the bias was very high upward, 16% and 18% in 1995 and 1996 respectively.

2.2 Present Methods

The current agricultural statistics, including crop area statistics, are usually gathered through the governorate and district Agricultural Affairs Offices. At each governorate and district level, extension agents carry out what is known as a “complete survey” to estimate the crop planted area. This information is usually recorded in notebooks kept with the extension agents, who are employed in the agricultural units (cooperatives) at the village level.

The extension agent at each agricultural unit is responsible for 150-250 feddans. The extension agent at the village level advises the farmers and gathers information about the major crops (planted area, agricultural inputs and output). Each extension agent is supposed to have a structured notebook in which information on major crops like cotton, rice, maize and wheat is recorded for each farmer at the *hod* level. There are two types of structured notebooks, one for cotton only the other for all other crops at the hod level. During the January-March period, the extension agents summarize all the information collected, including planted area, and pass it to the district level; those data are then forwarded to the governorate. This method is called a “complete survey” of all farms producing a specific crop. The agricultural departments at the district and governorate levels accumulate all the information and pass them to the higher levels Cairo/ MALR/EAS.

2.3 Findings

The MVE study team noticed the following:

- The currently method known as "a **complete survey"** is literally described, is just a subjective method used to collect information about the planted area by the local extension agents in the governorates. This was de duced by interviewing key people at the actual field.

- The Extension agents at the Agriculture Units usually advise the farmers about their prospective planted area in winter season and reports it to the agricultural units (coop) in January, and the same is usually done in March for the summer crops. The Agriculture units in each village send this information to the Agriculture Department in the district, which then releases it to the Agriculture department in the Governorate. This information is usually subjected to personal bias and provides low quality data.

- The study team asked an extension agent to bring his notebooks or sheets; it was found that they only have detailed information about cotton in summer and just the planted area of wheat in winter s eason.

- The team was told the method, which had been used in the past, about 5 years ago, used to be carried out twice a year, once in the winter and again in the summer season. The data collected were sent to the Bank of Development and Agriculture Credit branch in the district, which then made available agricultural inputs and marketed the agricultural products. This survey was really complete and used to produce good quality data; unfortunately it had been stopped since the Policy of PBDAC changed.

2.4 Survey by Sample Methods

Survey by the sample (using the complete survey year as base year) 1957-1996. A random of size 50% of total planted area was used to estimate wheat planted area in 1957 and for cotton and rice in 1958. The actual measurements were done by the ESA. The total planted area in each district was divided into primary sample units (clusters each of which has size about 2000 faddans), 50% of each district was selected each year and a sample list used to be sent to the ESA to estimate the planted area using an Egyptian measuring unit called *hasaaba*. These planted areas used to be color marked on maps of scale 1:2500. The net-planted areas were then measured and calculated by planimeter. The results used to be sent back to EAS/sampling department, where ratios were used to estimate the planted area relative to the base year.

Koshal (1962) proved that the standard error of the ratio estimates was less than of the average, according to the high correlation between crop area in the base and the current year. He also explained that, a sample of size 25% could be used for area estimates with standard error of only 0.5% at the governorate level.

Survey by sample (to correct Agriculture Department's data) 1990-1999. Mubarak (1977) indicated that the last base year, which was used to estimate crop area by sample was 1961. It is very far away to be used to estimate the current statistics of planted area of the major crops. So, it was recommended using the sampled area estimation to correct the agricultural surveyed data.

In 1990, the agricultural surveyed data was used, replacing the 1960 base year data and corrected by ESA actual measurement data obtained from a sample of size 50% of the total planted area using ratio estimates technique. However, this technique faced several problems, too:

- The primary sample unit definition was not unique or unified for ESA and agricultural departments.
- There were different names for the same *hod*.
- There were difficulties to verify the differences in the field.
- This technique was used from 1990-1999. The ESA's measurements shouldn't be influenced by any government officials; however much of their work was done in collaboration with the extension agents, thus, there might be some dependence at that level.

The sampling department used to aggregate all the planted area measurement data received from ESA. It then compared them with the total cultivated area of the same district received from the agricultural department (or the complete surveyed data). This surveyed data was then corrected using the ratio estimate technique as follows:

R=Y/X
Where;

Y=Crop planted area (Measured data).
X=the crop planted area (Complete surveyed data.)

And the surveyed is corrected as follows:

The corrected estimated area obtained by:
Y=RX

Mubarak (2001) made a comparison between the different methods of crop area estimation of wheat, cotton and rice grown in 1998; the results are shown in Table 1.

Table 1: Crop Area Estimation Using Different Methods in 1998

(1000 feddans)

Methods	Wheat		Cotton		Rice	
	Feddans	**Index no.**	**Feddans**	**Index no.**	**Feddans**	**Index no.**
ESA-before adjustment	1858	93	1029	131	1969	159
ESA-After adjustment	1936	97	800	102	1307	106
Agricultural Department	1985	99	806	103	1218	99
Final estimation committees	1999	100	773	100	1236	100

Results in Table 1 showed different values, especially that of ESA before verifying and adjustment compared with other methods for rice crops, where its estimation was increased by 59% from the final estimation. Therefore, it is essential to check, verify and adjust ESA data to increase its quality and make the right adjustment in the data or in the methodology.

This method was not only expensive, (about LE. 2 million annually), but also its quality was questionable. Unfortunately, this objective method has been stopped since the beginning of year 2000. Therefore, the only available source for the planted area information is what is called Agricultural Department data, the subjective one.

Therefore, it was essential for the Ministry of Agriculture to come up with an alternative method to check and evaluate the cotton planted area and the other major summer crops like rice and maize. This is the goal of this study.

Mubarak (2001) introduced a pilot study to adjust and verify the agricultural area data of wheat. A multistage stratified sample of total size 28 fields was selected from three governorates (8 from Behira, 8 from Gharbia and 12 fields from Assuit). Sampled fields of wheat in the 1999/2000 season were measured using the tape and compared with the agricultural data. In Behira, data analysis indicated a 14% difference between the actual measurement and the agricultural data, and the ratio estimate of both was 0.86 respectively. While in Gharbia, the difference was about 7% between the actual measurement and the agricultural data and the ratio estimate was 0.93. Results in Assuit showed also negative difference between the actual measurements and the agricultural data, and the ratio estimate was about 0.93. He used the ratio and regression estimate to correct the agricultural data in the three governorates under the study.

3. TESTING A CHECK SAMPLE AND OPTICAL INSTRUMENTS

In this pilot study, it is assumed that any governorate consists of a population of area units (fields) distributed over a geographic area. Each governorate is divided into districts and each district is divided into a known number of clusters (village, basin or group of small basins) of different crop fields. Each cluster is uniquely defined with physical boundaries and its area ranged from 150 to 250 feddans. Each is divided into a known number of fields, each of which has a measured planted area. The parameter of interest is the total planted area at the district and governorate levels. Selecting a sample of clusters and a sub sample of crop fields from the selected clusters collects the planted area information. Therefore, a cluster sub-sampling scheme is used to get a representative sample to estimate the major summer crops planted area in the studied districts and governorates. For the economy of the yield work and supervision, it was decided as far as possible to purposively select the cotton forecasting clusters, from each selected districts, which have at least the three studied summer crops namely, cotton, maize and rice. Cluster is considered as the primary sampling unit, while the crop field is the secondary sampling unit. However, the study considered the randomization selection, only during the crop field selection in the second stage. It should be noticed that the new applied technique is called a check sample procedure. The improved method suggested by the team consists of two parts. The first one is to apply the check sample techniques, and the second part is to test new instruments (optical instruments) in measuring fields.

3.1 Methodology

The following statements outline the actions taken by the MVE team as they worked to accomplish their goals:

- Select a team comprised of MALR, ARC, University, and staff experts.
- Establish the goa ls for area estimation.
- Review all past reports, instructions, manuals, models, and data.
- Review all available data and how they were used to make area forecasting.
- Observe current fieldwork, documents and estimation process.
- Field observations of current procedures applying the new instruments.
- Suggest and test new procedure and forms
- Recommend models for future forecasting work along with a schedule of implementation.
- Recommendations for improved sampling procedures.
- Recommend improvements to survey procedures and forms.
- Recommended procedures and models that should provide accurate, timely, cost effective forecasts and be manageable. If possible include an estimate of manpower, equipment and budget requirements.

3.2 Implementation

1. The MVE team visited several governorates (Gharbia, Minya, Assuit, Behira and Dakahlia) During June and July to assist the existing systems of planted area estimation methods used by EAS / MALR.
2. The MVE Planted area estimation team interviewed a few key informants in each visited governorate. They collected information about the flow of planted area data of the major summer crop from the agricultural units in the village to the agricultural departments in the governorate via the districts, i.e.

    - The team interviewed the director of the sampling department in each district and governorate.
    - The MVE team interviewed the local agriculture extension agents and farmers in the selected villages. They also collected information about how data are collected on crop rotations and the planted area of major summer crops, especially cotton, maize and rice.

3. The MVE team, using its own staff and in cooperation with the sampling local staff, double checked the selected planted area measurements using two methods:

    - Tape measurements.
    - Instrument measurements.

3.3 Study Areas, Sample Selection and Operational Work

The MVE team decided to choose five governorates based on their relative importance in the total planted area of cotton, maize and rice, as well as to provide dispersion geographically. Those governorates are Gharbia, Minya, Assiut, Behira and Dakahlia.

Applying the above mentioned survey procedure, three districts were purposively selected from Gharbia, Minya and Assiut, while four districts were selected from Behira and Dakahlia. A two-stage cluster sample has used to select two clusters from each selected district, and a few different numbers of the studied crop fields were randomly selected from each selected cluster based on the relative importance of the planted area of the studied crop. For example, four cotton forecasting fields were selected in some governorates to compare the results with the ongoing cotton forecasting study. Also, three fields were selected from each cluster in the second stage to increase the sample size in the other governorates, namely Minya and Assuit, which have only cotton and maize grown there. This diversity of the studied areas, different crops and representative sample enabled testing for differences between different methods of crop area estim ation.

The MVE team assigned three working days in each studied governorate; however, the field trips to Bahira and Dakahlia were extended one day more. They interviewed key informants in each governorate: directors of sampling departments at the district and governorate levels and local farmers and extension agents at the district and village levels. Subjective information about the planted area was collected. In addition, all sampled fields of cotton, maize and rice were visited and actually measured by the study team. Objective field measurements were obtained using tape measurements and the new instruments. All these actual measurements of the selected fields were illustrated on sketches in the field.

A multidisciplinary team consisting of a senior statistician, senior agricultural engineer, agricultural economist and research assistant was assigned to assess the past and present methods used by MALR/EAS for crop area estimation and suggest a new method to improve sampling procedures and proper way to estimate crop area. The team started the operational work in Gharbia on 23 of June 2001. Then the team took a field trip to Minya and Assuit during the period 29/6 to 5/7/2001. Bahira was visited during the period 9-12/7/2001 while Dakahlia was visited during 16-19/7/2001. During these visits, the team members spent long days measuring the selected fields, interviewing key people, and training the sampling local staff on the right way to measure the field area. A double check of the calculated field area was also carried out using tape measurements and new instruments to assist and verify the present work.

Many difficulties were encountered during the operational field work, ranging from flooded fields, misallocated the selected clusters and fields. Field trip details are explained hereinafter.

3.4 Findings

The MVE team found that:

- If the field is nearly rectangular in the shape, two enumerators used a measuring tape to get the length of one long and one short side. The area of the field is calculated by multiplying the length by the width. But this was not always the case in all fields that the MVE team visited.

- In most of the cases, the sides of the fields were curved, and the shape is quite complex.

- Sampling staff don't note down how many times the tape was fully unwound.

- When they measure the field, some sampling enumerators don't fully unwind the tape.

- When the local team was asked, how could they measure these irregular shapes, they answered that these fields could be broken up into triangles and rectangles, which can be used to derive the area of the field.

- When they were asked, how could the area of the triangle be calculated, they said by measuring the lengths of two sides and the angle in between. The full area could then be obtained. How can you get the angle? They said by using an instrument called the "survey triangle".

- However when the MVE team asked the local sample team to measure the angle on the selected field they failed to do it. The MVE team felt that the survey triangle tool was never used in area measurements in the selected fields.

- Some local sampling staff told the MVE team that they only measure the length and width of the selected field, and if the field shape is not rectangular, they said they just measured the four sides of the field and average the two lengths and the two widths and multiply the two averages to get the field area.

- Most of the selected fields were not well located, except those of the cotton forecasting fields. These difficulties stemmed from either confusing farmer names or hod names. In addition, quite a few clusters were reduced in size. This was noticeable in some governorates, where the clusters are very close to urban areas, eg. El Agami cluster (about 100 feddans only) at Qotour district in Gharbia, . Therefore, **it is very essential to establish or update the National Statistical Sampling Fram**e.

- In a few selected fields, which have very long lengths and narrow widths, the MVE team discovered that the local team just measured the width, while the lengths were calculated by dividing the prospective field area by the measured width. This was noticeable in Minya and Gharbia governorates.

- In Assuit and Dakahlia, the local team convinced the MVE team that all sides of the selected fields were measured.

4. DATA ANALYSIS AND DISCUSSION

4.1 Background

For sample survey designs, simple and stratified random sampling, cluster sampling, it is assumed that the data were correctly recorded and provided an accurate representation of the n elements sampled from the population. Under these assumptions, the population parameters were estimated accurately.

In this pilot survey, these assumptions were not fulfilled. First, the recorded measurements of the area estimation methods were not always accurate representations of the desired data because of biases of some of the interviewers or measuring equipments. Second, the existing statistical frame in each studied governorate is very old and not always complete nor accurate. Hence, the chosen sample might not have been selected from the complete population. Third, obtaining accurate sample data might be impossible because of the sensitive nature of the questions, interviewers or enumerators.

In this paragraph, the study used what is called the interpenetrating subsamples method as suggested by Scheaffer et al (1990) for analyzing data when measurement errors are presented or an inadequate frame is used.

Using the above mentioned technique, the sample in each governorate was divided into three subsamples in Lower Egypt governorates or two subsamples in Middle and Upper Egypt governorate based on the number of the major summer crops. Therefore, in each governorate in Delta, there were three subsample for area estimation of cotton, maize and rice crops. While in Minya and Assuit there were only two subsamples; one for cotton and the other for maize.

4.2 Statistical Analysis

A matched pair t-test was used to compare between the four methods of area estimation measurements that used in this study. That is, (1) Instrument measurement, (2) Tape measurement by sampling staff, (3) Farmer estimate, and (4) Extension agents' estimates. In addition, the ratio estimator was used for estimating the correction factor that will be recommended for agricultural extension data adjustment. There is an analogy between the ratio estimator and classical regression analysis. In the classical regression setting of infinite population, suppose the fitted model

$$E(y_i) = b \cdot x_i \qquad (1)$$

Since, y_i and x_i are two area measurements which were obtained from the same field using two different methods, it is expected that the variance of y_i is proportional to x_i. Then, a standard least squares weighted regression analysis with weights 1/xi will produce r as the estimator of b

SPSS- was used to estimate r crop wise in each governorate under the study.

4.2.1 Ratio Estimates of Cotton, Maize and Rice in Gharbia Governorate

Data analysis showed significant difference between new instrument, Visit and Sampling measurements against the agricultural extension data from maize subsample only. However; T-Paired test analysis showed significant difference between new instrument and Visit measurements against Sampling measurements in rice subsample. Hence, the study produced only the ratio estimates of the New instrument and visit against the extension data using the weighted regression analysis

Results of weighted regression analysis which are summarized in Table 2 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton, maize and rice respectively which were as follows:

$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN} \quad (1.1)$$

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN} \quad (1.2)$$

$$\hat{y}_{NEWINS} = 1.001 \cdot y_{EXTEN} \quad (1.3)$$

Table 2: The Estimated Coefficient of Cotton, Maize and Rice

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1.00	1	EXTENSIO	.942	.075	.967	12.510	.000	.776	1.108
2.00	1	EXTENSIO	.763	.055	.973	13.919	.000	.642	.884
3.00	1	EXTENSIO	1.001	.055	.984	18.046	.000	.879	1.123

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .154, .110 and .111 (1.4)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, maize and rice less than 0.16, 0.12 and 0.12 respectively. That is, the true correction ratio R for the population were between the following intervals:
95% C.I.= (0.78,1.11), (0.64,0.88) and (0.89,1.12),
(1.5)

For cotton, maize and rice area estimation in Gharbia using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 3 showed the fitted regression equations of the sampling visit measurements on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{VISIT} = 0.97 \cdot y_{EXTEN} \qquad (1.6)$$

$$\hat{y}_{VISIT} = 0.76 \cdot y_{EXTEN} \qquad (1.7)$$

$$\hat{y}_{VISIT} = 1.004 \cdot y_{EXTEN} \qquad (1.8)$$

Table 3: The Estimated Coefficient of Cotton, Maize and Rice

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.970	.082	.963	11.848	.000	.790	1.150
2.00	1	EXTENSIO	.760	.048	.979	15.756	.000	.654	.866
3.00	1	EXTENSIO	1.004	.058	.982	17.437	.000	.878	1.131

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .164, .094 and .110
(1.9)

The t-ratio and p-value and 95%confedence intervals in Table 3 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the standard errors of the estimates less than 0.17, 0.10 and 0.12 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.79,1.15), (0.65,0.87) and (0.89,1.13), (1.10)

For cotton, maize and rice area estimation in Gharbia using the new instrument measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired test analysis, however analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in

(1.5) were mostly shorter than the visit measurements method in (1.10). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Gharbia.

Therefore, the study recommended the following fitted equations in Gharbia

$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 1.001 \cdot y_{EXTEN}$$

For cotton, maize and ric e area estimation adjustment respectively

4.2.2 Ratio Estimates of Cotton And Maize In Minya Governorate

Data analysis applying "T-Pared test Statistic, showed significant difference between New instrument and Sampling measurements against the agricultural extension data from cotton subsample at 5% significant level. While, it showed the same results at 10% level in maize subsample. However, T-Paired test analysis showed no significant difference between new instrument, visit and sampling measurements . Hence, the study produced only the ratio estimates of the New or visit instrument and visit against the extension data using the weighted regression analysis

Results of weighted regression analysis which are summarized in Table 4 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN} \tag{2.1}$$

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN} \tag{2.2}$$

Table 4: The Estimated Coefficients of Cotto n and Maize

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			5% Confidence Interval for B	
CROP	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENTIO	.760	.050	.966	15.297	.000	.655	.864
2.00	1	EXTENTIO	.763	.083	.913	9.239	.000	.589	.937

a. Dependent Variable: NEWINSTR

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .10 and .166 (2.3)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, and maize less than 0.11 and 0.17 respectively. That is, the true correction ratio R for the population were between the following intervals:

95% C.I. = (0.66,0.86) and (0.59,0.94), (2.4)

For cotton and maize area estimation in Minya using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 5 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{VISIT} = 0.82 \cdot y_{EXTEN} \quad (2.5)$$

$$\hat{y}_{VISIT} = 0.79 \cdot y_{EXTEN} \quad (2.6)$$

Table 5:The Estimated Coefficient of Cotton and Maize

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			5% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.747	.052	.948	14.250	.000	.638	.855
2.00	1	EXTENSIO	.819	.050	.970	16.498	.000	.714	.924

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .114 and .156 (2.7)

The t-ratio and p-value and 95%confedence intervals in Table 5 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation were less than 0.12 and 0.16 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.69,0.94) and (0.63,0.96), (2.8)

For cotton, maize and rice area estimation in Minya using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired test analysis, however analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in (2.4) were mostly shorter than the visit measurements method in (2.8). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Minya.

Therefore, the study recommended the following fitted equations in Minya

$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$$

For cotton and maize area estimation adjustment respectively

4.2.3 Ratio Estimates of Cotton and Maize in Assuit Governorate

Data analysis applying matched pair t-test statistic, showed significant difference between New instrument, Visit and Sampling measurements against the agricultural extension data from cotton subsample . While, it showed significant difference only for New instrument and Visit against the agricultural extension in maize subsample. However, T-Paired test analysis showed significant difference between Visit and sampling at 10% level of significance and no significant difference between new instrument and visit measurements. Hence, the study produced only the ratio estimates of the new instrument or visit against the extension data using the weighted regression analysis.

Results of weighted regression analysis which summarized in Table 6 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{NEWINS} = 0.73 \cdot y_{EXTEN} \tag{3.1}$$

$$\hat{y}_{NEWINS} = 0.87 \cdot y_{EXTEN} \tag{3.2}$$

Table 6: The Estimated Coefficients of Cotton and Maize

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	5% Confidence Interval for B Lower Bound	5% Confidence Interval for B Upper Bound
1.00	1	EXTENSIO	.734	.056	.940	13.169	.000	.619	.849
2.00	1	EXTENSIO	.870	.039	.984	22.517	.000	.789	.952

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .112 and .078 (3.3)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, and maize were less than 0.12 and 0.08 respectively. That is, the true correction ratio R for the population were between the following intervals:

95% C.I. = (0.62,0.85) and (0.79,0.95), (3.4)

For cotton, maize and rice area estimation in Assuit using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 7 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton and maize respectively were as follows:

$$\hat{y}_{VISIT} = 0.75 \cdot y_{EXTEN} \quad (3.5)$$

$$\hat{y}_{VISIT} = 0.82 \cdot y_{EXTEN} \quad (1.6)$$

Table 7: The Estimated Coefficient of Cotton and Maize

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	5% Confidence Interval for B Lower Bound	Upper Bound
1.00	1	EXTENSIO	.747	.052	.948	14.250	.000	.638	.855
2.00	1	EXTENSIO	.819	.050	.970	16.498	.000	.714	.924

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton and maize respectively are:

2(Std. Error) = .104 and .100
(3.7)

The t-ratio and p-value and 95%confedence intervals in Table 7 showed that, in the infinite normal population setting, the regression coefficient were significantly different from zero. Hence, we are quite confident that the errors of the estimation were less than 0.11 and 0.11 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.64,0.86) and (0.71,0.92),
(3.8)

For cotton and maize area estimation in Assuit using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the matched pair t-test analysis, however analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in (3.4) were mostly shorter than the visit measurements method in (3.8). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Assuit.

Therefore, the study recommended the following fitted equations in Assuit

$$\hat{y}_{NEWINS} = 0.73 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.87 \cdot y_{EXTEN}$$

For cotton and maize area estimation adjustment respectively

4.2.4 Ratio Estimates of Cotton, Maize and Rice in Behira Governorate

Data analysis applying matched pair t-test statistic, showed significant difference between New instrument, Visit and Sampling measurements against the agricultural extension data from cotton subsample. Also there was significant difference between Visit and sampling under the subsample of cotton. However; T-Paired sampled tests showed no significant difference between all methods measurements in maize and rice subsample. Hence, the study produced only the ratio estimates of the New instrument and visit against the extension data using the weighted regression analysis

Results of weighted regression analysis which are summarized in Table 8 showed the fitted regression equation of the new instrument measurement on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{NEWINS} = 0.78 \cdot y_{EXTEN} \tag{4.1}$$

$$\hat{y}_{NEWINS} = 0.88 \cdot y_{EXTEN} \tag{4.2}$$

$$\hat{y}_{NEWINS} = 0.96 \cdot y_{EXTEN} \tag{4.3}$$

Table 8: The Estimated Coefficients of Cotton, Maize and Rice

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.783	.048	.973	16.379	.000	.681	.885
2.00	1	EXTENSIO	.877	.110	.893	7.939	.000	.643	1.111
3.00	1	EXTENSIO	.961	.082	.950	11.768	.000	.787	1.135

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .096, .220 and .164 (4.4)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficient were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, maize and rice were less than 0.16, 0.12 and 0.12 respectively. That are, the true correction ratio R for the population were between the following intervals:

95% C.I.= (0.68,0.88), (0.64,1.11) and (0.79,1.13), (4.5)

For cotton, maize and rice area estimation in Behira using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 9 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{VISIT} = 0.79 \cdot y_{EXTEN} \quad (4.6)$$

$$\hat{y}_{VISIT} = 0.85 \cdot y_{EXTEN} \quad (4.7)$$

$$\hat{y}_{VISIT} = 0.94 \cdot y_{EXTEN} \quad (4.8)$$

Table 9: The Estimated Coefficients of Cotton, Maize and Rice

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1.00	1	EXTENSIO	.789	.046	.975	17.025	.000	.690	.888
2.00	1	EXTENSIO	.846	.109	.889	7.786	.000	.616	1.076
3.00	1	EXTENSIO	.943	.087	.942	10.883	.000	.758	1.127

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .092, .218 and .174
(4.9)

The t-ratio and p-value and 95%confedence intervals in Table 10 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the standard errors of the estimates less than 0.10, 0.22 and 0.18 respectively. That is, the true correction ratio R for the population were between

95% C.I. = (0.69,0.89), (0.62,1.08) and (0.76,1.13), (4.10)

For cotton, maize and rice area estimation in Behira using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired sample test analysis. However, analysis of regression showed that, the 95% confidence intervals of the ratio estimates of new instruments in (4.5) were mostly shorter than the visit measurement method in (4.10). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Behira.

Therefore, the study recommended the following fitted equations in Behira

$$\hat{y}_{NEWINS} = 0.78 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.88 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.96 \cdot y_{EXTEN}$$

For cotton, maize and rice area estimation adjustment on the agricultural extension data obtained from the agricultural Departments on the district under the study:

4.2.5 Ratio Estimates of Cotton, Maize and Rice in Dakahlia Governorate

Data analysis applying "T-Pared sampled test, showed significant difference between New instrument, Visit and Sampling measurements against the agricultural extension data from cotton subsample. There was no significant difference between New Instrument, Visit and Sampling methods under the subsample of cotton. However; T-Paired sampled tests showed no significant difference between New Instruments and Visit methods measurements in maize cotton subsample, as well as between Sampling and Extension in maize and rice. But there was significant difference between New Instruments and Visit methods under rice subsample. Hence, the study produced only the ratio estimates of the New instrument and visit against the extension data using the weighted regression analysis.

Results of weighted regression analysis which summarized in Table 10 showed the fitted regression equations of the new instrument measurement on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{NEWINS} = 0.89 \cdot y_{EXTEN} \tag{5.1}$$

$$\hat{y}_{NEWINS} = 0.92 \cdot y_{EXTEN} \tag{5.2}$$

$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN} \tag{5.3}$$

Table 10: The Estimated Coefficients of Cotton, Maize and Rice

Coefficients[a,b,c]

			Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
CROPS	Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1.00	1	EXTENSIO	.891	.040	.978	22.387	.000	.809	.973
2.00	1	EXTENSIO	.919	.028	.993	32.855	.000	.859	.978
3.00	1	EXTENSIO	.935	.061	.969	15.273	.000	.804	1.065

a. Dependent Variable: NEWINST

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .080, .056 and .122 (5.4)

The t-ratio and p-value and 95%confedence intervals showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the errors of the estimation of cotton, maize and rice were less than 0.09, 0.06 and 0.13 respectively. That is, the true correction ratio R for the population were between the following intervals:

95% C.I.= (0.81,0.97), (0.86,0.98) and (0.80,1.06),
(5.5)

For cotton, maize and rice area estimation in Dakahlia using the new instrument measurements.

Results of weighted regression analysis which are summarized in Table 11 showed the fitted regression equations of the visit measurements on the agricultural extension data for cotton, maize and rice respectively were as follows:

$$\hat{y}_{VISIT} = 0.91 \cdot y_{EXTEN} \quad (5.6)$$

$$\hat{y}_{VISIT} = 0.93 \cdot y_{EXTEN} \quad (5.7)$$

$$\hat{y}_{VISIT} = 0.96 \cdot y_{EXTEN} \quad (5.8)$$

Table 11: The Estimated Coefficients Of Cotton, Maize And Rice

Coefficients[a,b,c]

CROPS	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	5% Confidence Interval for Lower Bound	5% Confidence Interval for Upper Bound
1.00	1	EXTENSI(	.913	.030	.988	30.467	.000	.851	.975
2.00	1	EXTENSI(	.929	.032	.991	29.006	.000	.860	.997
3.00	1	EXTENSI(	.961	.063	.969	15.199	.000	.827	1.096

a. Dependent Variable: VISIT

b. Linear Regression through the Origin

c. Weighted Least Squares Regression - Weighted by WEIGHT

The bound of the errors area estimation of cotton, maize and rice respectively are:

2(Std. Error) = .06, .064 and .126
(5.9)

The t-ratio and p-value and 95%confedence intervals in Table 11 showed that, in the infinite normal population setting, the regression coefficients were significantly different from zero. Hence, we are quite confident that the standard errors of the estimates less than 0.07, 0.07 and 0.13 respectively. That is, the true correction ratio R for the population were between

$$95\% \text{ C.I.} = (0.85,0.98), (0.86,1.00) \text{ and } (0.83,1.10), \qquad (5.10)$$

For cotton, maize and rice area estimation in Dakahlia using the Visit measurements.

Data analysis showed no significant difference between the new instrument and visit methods as it was shown in the T-paired sample test analysis, except in rice subsample there was significant difference between New Instrument and Visit methods. Analysis of regression also, showed that, the 95% confidence intervals of the ratio estimates of new instruments in 51.5) were mostly shorter than the visit measurement method in (5.10). Thus, the ratio estimates (correction factors) obtained from the new instruments were more efficient to be used in crop area estimation and were recommended in Dakahlia.

Therefore, the study recommended the following fitted equations in Dakahlia

$$\hat{y}_{NEWINS} = 0.89 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.92 \cdot y_{EXTEN}$$
$$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$$

For cotton, maize and rice respectively for area estimation adjustment on the agricultural extension data obtained from the agricultural Departments:

4.3 Summary

Data analysis showed significant difference between the New Instrument, Sampling staff and Visit methods against the Extension data in all governorates under study and in almost all crops under study. The exceptions were a few cases in Gharbia, where there were no significant differences. However; matched pair t-test analysis showed significant differences between the new instrument and Visit measurements against the Sampling measurements in some crops under the study.

The results of weighted regression analysis showed that the fitted regression equations of the New Instrument measurement on the agricultural extension data, for almost all the major summer crops under study, were more efficient in reducing the estimates errors bound. The 95% confidence intervals of the ratio estimates of New Instruments for almost all crops were shorter than that of the Visit measurement method. Thus, the ratio estimates (correction factors) obtained from the New instruments were more efficient to use in crop area estimation and are recommended. The fitted equations of the weighted ratio regression for cotton, maize and rice as well as the total crop area obtained from the agricultural department before adjustment and after adjustment are summarized in Table 12.

Table 12: Crop Area Estimates Adjusted by Weighted Ratio Estimate using New Instrument Measurements, 2001

(1000 feddans)

Governorate, crops	Standard Weighted Ratio Model	Extension data y_{EXTEN}	Estimated y_{NEWINS}	%
Gharbia	$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$			- 6
cotton	$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$	58	45	- 24
maize	$\hat{y}_{NEWINS} = 1.001 \cdot y_{EXTEN}$	231	176	+0 .1
rice		141	142	
Minya				- 24
cotton	$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$	34	26	- 24
maize	$\hat{y}_{NEWINS} = 0.76 \cdot y_{EXTEN}$	30	23	
Assuit				
cotton	$\hat{y}_{NEWINS} = 0.73 \cdot y_{EXTEN}$	32	24	- 27
maize	$\hat{y}_{NEWINS} = 0.87 \cdot y_{EXTEN}$	82	71	- 13
Behira				
cotton	$\hat{y}_{NEWINS} = 0.78 \cdot y_{EXTEN}$	160	125	- 22
maize	$\hat{y}_{NEWINS} = 0.88 \cdot y_{EXTEN}$	163	144	- 12
rice	$\hat{y}_{NEWINS} = 0.96 \cdot y_{EXTEN}$	205	196	- 4
Dakahlia	$\hat{y}_{NEWINS} = 0.89 \cdot y_{EXTEN}$			
Cotton		93	82	- 11
maize	$\hat{y}_{NEWINS} = 0.92 \cdot y_{EXTEN}$	100	92	- 8
rice	$\hat{y}_{NEWINS} = 0.94 \cdot y_{EXTEN}$	395	371	- 6

Results in Table 6.1 indicate that agricultural extension data are an overestimation ranging from 4% to 27% for the planted areas of the major summer crops except for the rice area estimation in Gharbia, which had a downward bias of 0.1 %.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the above discussion and results of matched pair t-test and weighted regression analysis, the study concludes that the New Instrument and Visit measurement and there was no significant differences between New Instrument and Visit measurements for most of the crops. However, in most of the cases the 95% confidence intervals using the New Instruments were shorter than that of the Visit method. Hence, it is concluded that the New Instrument was more efficient than all other measurement methods.

5.2 Recommendations

- Apply the proposed method, including the new instruments, in one or more governorates.
- Use the surveying level instrument with fixed hair stadia method to perform easy, quick and accurate results.
- Continue applying the proposed procedure annually in order to derive the correction factor for crop area estimation adjustment to the extension agent estimates studied governorates.
- The staff members need a comprehensive training course in how to use the new instruments in measuring lengths and angles, and how to plot their traverses.

Suggested Training Program

Time	Class	Subject
2 hrs	Lecture	General rules for measuring distances
3 hrs	Training	Taping and chaining using alignment method
2 hrs	Lecture	General rules for measuring angles
3 hrs	Training	Magnetic compass for measuring direction and internal angles.
2 hrs	Lecture	Theodolite: theory and its components. Tachometric process for measuring distances.
4 hrs	Training	How to use Theodolite for measuring distances and angles (vertical and horizontal).
2 hrs	Lecture	Surveying level, theory and its application to measure distances and angles.
4 hrs	Training	How to use surveying level.
2 hrs	Lecture	Planimeter theory for measuring maps area of curved shapes
4 hrs	Training	How to use the planimeter for measuring area of maps

6 hrs	Training	Project Perform real field work estimating the area of different shapes and plotting its sketches with respect to the internal angles and direction. Learn how to correct any fieldwork using closing correction method.

N.B.

- In training there should not be more than 4 trainees per instrument.
- The program needs one professor to give, lectures and supervise the training classes, and one demonstrator for each instrument.

REFERENCES

Koshel, R., S. **Estimation of Area under Principle Crops, Ministry of Agriculture, Egypt.** 1962.

FAO Publication. **Estimation of Crop Areas and Yield in Agricultural Statistics.** Rome, 1982.

USDA. **Scope and Methods of the Statistical Reporting Service, M., P., No.1308.** Washington, D.C. 20250, 1983.

Fawzy, M., A., *et al.* **Availability and Quality of Agriculture Data in Egypt.** MVE Unit/APRP. Egypt, 1998.

EAS. **A Pilot Study To Verify The Cotton Area Data.** Ministry of Agriculture, Egypt, 2000.

Mubarak, R., M. **Improvement of Agricultural Crops Area Statistics in Egypt.** AERI, ARC, Egypt, 2001.

ANNEX